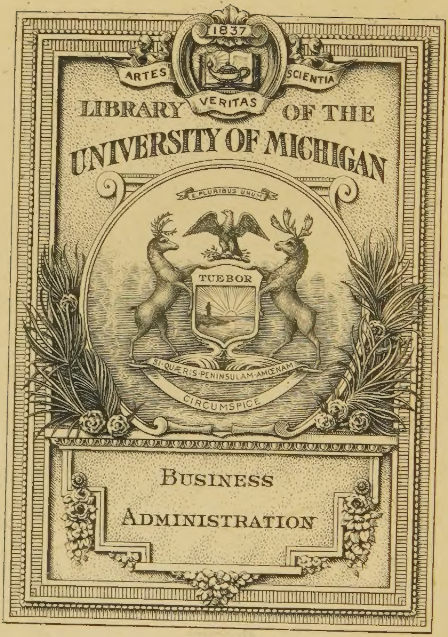

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ACCOUNTING
FOR THE
PETROLEUM INDUSTRY

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ACCOUNTING
FOR THE
PETROLEUM INDUSTRY

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FOREWORD

by J. Hugh Jackson

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School of Business Administration

The recent developments in accountancy in most of the technical fields of business activity have probably kept pace with the advancements in business itself. Because of the rapidity with which these changes have come about, however, accounting literature has not, in most cases at least, kept abreast of the science. With every advance or development in accountancy there also comes a need for reliable literature to guide and assist those who are responsible for carrying out the new program.

The authors have attempted not only to set forth the accounting principles and procedures applicable to petroleum, but also some of the technical practices of the industry. The present-day accountant must first of all know the industry which he is serving; he should be familiar with its problems, and must be able to visualize what reports and information will be helpful to the business executive and the operating personnel. Accounting falls short of its duty to a business organization unless it proves itself an effective aid to good administration and control.

Four major activities confront the petroleum industry, namely the production, transportation and storage, refining, and marketing functions. Separate treatment has accordingly been given to each of these; first of all a general statement of the problem to be solved in each activity has been made. When the reader comprehends the general practices followed in producing petroleum, for example, and the problems which are encountered, he will much more readily grasp the accounting procedures necessary or desirable. Because of the peculiar complications arising under the Federal Revenue Acts with reference to the petroleum industry, a fifth general division of the book is given to Federal taxes. The questions relating to discovery values, depletion of gas and oil properties, capital gains and losses, and similar problems call for a somewhat specialized and technical treatment.

While the book has been written primarily for accountants and for those who are engaged in the petroleum industry, it is believed that it will prove of value to all who are interested in the agencies of administrative control; it is also believed that it will fill a place in technical accounting courses, and that it will prove to be a valuable reference work in advanced accounting courses where the accounting problems of specific industries are studied. The book deals not with accounting theories, but with procedures and the practical problems encountered by the authors in years of public accounting work in the petroleum industry.

So diversified is the work of the public accountant, and so varied are the circumstances surrounding each business or each industry that a very wide experience must be drawn upon if the study is to result in a scientific contribution to the profession, or to the industry interested. Through the firms with which the authors have been associated they have had access to materials representing experiences broader than any individual could hope to have; by so much they have added to accounting literature the fruits of the practitioner's experience. The content and expression of the book are their own, but everyone interested in accountancy should rejoice that so great a storehouse of information has been available to them. Both the authors and their firms have contributed to the upbuilding of a great professional literature.

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ACCOUNTING FOR THE PETROLEUM INDUSTRY

INTRODUCTION

Technical treatises dealing with various lines of activity arising out of the petroleum industry usually hark back in historical reminiscence to the stirring days at Titusville and Oil City in the late fifties, touch briefly upon the Drake Well and the Tarr Farm Pipe Line in the course of narration, and finally bring the reader forward to the industry's present state of development, with its Teapot Domes, Senate Investigating Committees, Foreign Concessions, Gasoline Trusts, and what not.

The present work, however, is designed merely to present a system of accounting for the oil industry and, except where peculiar features make technical explanation advisable in order better to present the subject matter, operating procedure is only indicated in a general manner. Those who wish to study the technical phases of the industry in greater detail are referred to such standard works as "American Petroleum Industry," by Bacon and Hamor; "Petroleum and Its Products," by Sir Boverton Redwood; "A Handbook of the Petroleum Industry," by David T. Day; and the more specialized works of Dorsey Hager, R. P. McLaughlin, Henry P. Westcott, Dr. Roy Cross, and others.

Since the first production of oil in the United States, in 1859, the industry has grown to immense proportions, and at the present time ranks second only to that of meat-packing measured by the value of the products. In January, 1924, there were over 286,000 producing oil wells, between 600 and 700 refineries, and some 135,000 tank cars in America, and the industry's investment has been estimated at over eight billion dollars, divided as follows:

Production	$4,000,000,000
Refining	2,000,000,000
Marketing	800,000,000
Pipe lines	700,000,000
Tank cars	270,000,000
Tank steamers	430,000,000
Total	$8,200,000,000

Hardly a day passes that there is not conceived some new and very practical application of a petroleum derivative to the everyday needs of man. This progress, except indirectly, is not the result of centuries of research and accumulated knowledge, but rather of the insistent demands of our twentieth century industrial and social evolution.

Origin of Petroleum.—Authorities differ as to the probable origin of oil and gas, but perhaps the two most widely accepted theories are what are known as the *organic theory* and the *volcanic theory*.

According to the organic theory, vast terrestrial upheavals took place millions of years ago during the cooling of the earth's crust. Beneath the debris myriads of living organisms were buried, and this organic matter, acted upon by natural agencies, gradually formed, through countless centuries, the crude petroleum which we know today. The exponents of the volcanic theory are just as emphatic in their views as are those of the organic theory, and the following abstract from an article by Eugene Coste, E.M.[1] will be of interest:

> I now pass to my second paragraph in which I propose to show that all the petroleum, natural gas and bituminous fields or deposits cannot be regarded as anything else but the products of solfataric volcanic emanations condensed and held in their passage upward, in the porous tanks of all ages of the crust of the earth from the Archæan rocks to the Quaternary, or in veins, fissures and seams in the case of solid bitumens. Nothing is so simple and therefore nothing so natural as this origin. It can be abundantly proven . . .

Those who wish to study the various theories upon the subject in more detail are referred to "American Petroleum Industry," by Bacon and Hamor.

Crude petroleum varies widely in its composition but for convenience is broadly divided into classes, according to its base.

---

[1] "*Handbook of Natural Gas,*" edited by the late Henry P. Westcott, Metric Metal Works, Erie, Pa.

The following is a table showing the oil bases in the American fields:

Field	Base of Oil
Alaska	Paraffin
Appalachian	Paraffin
California	Asphalt
Colorado	Paraffin
Gulf-coast	Asphalt
Illinois	Paraffin and mixed
Lima-Indiana	Paraffin
Mid-continent	Paraffin, asphalt and mixed
Michigan	Paraffin
Wyoming	Paraffin and asphalt

Early History of Industry.—Commercially petroleum has been recognized for several thousand years. In ancient China it was produced by methods very similar to those employed by the modern prospector, and a very interesting article on the Chinese method may be found in the June 14, 1923, issue of *The Oil and Gas Journal.*

A description in the Book of Genesis of the building of the Tower of Babel reads, "and slime had they for mortar." This slime was probably the bitumen, essentially the same as asphalt, which the Egyptians used for embalming; Plutarch also mentions a deposit in Albania on the Adriatic Sea. Quite probably a certain amount of refining, or rather reducing, was done by the ancients, and unquestionably the value of blending crude petroleum with other oils was early discovered.

The principal sources of supply until the latter part of the preceding century, however, were the pitch lakes, oil springs, and other natural outcroppings; *Seneca Oil* from a spring near Lake Seneca in Allegheny County, Pennsylvania, was used by the Indians as a liniment for several hundred years. In connection with natural outcroppings the following observation in the daily press is of interest:

> Baku, Azerbajan, Nov. 3, 1923.—Due probably to shifting strata in the Caspian Sea, an unusual phenomenon in oil wells was noticed recently near here. A geyser began erupting from the sea, 2 miles off the coast, and for 2 hours spurted to a height of 70 feet, throwing off gas and oil. The eruption was accompanied by flames. On the spot a small island formed after the gusher died down.

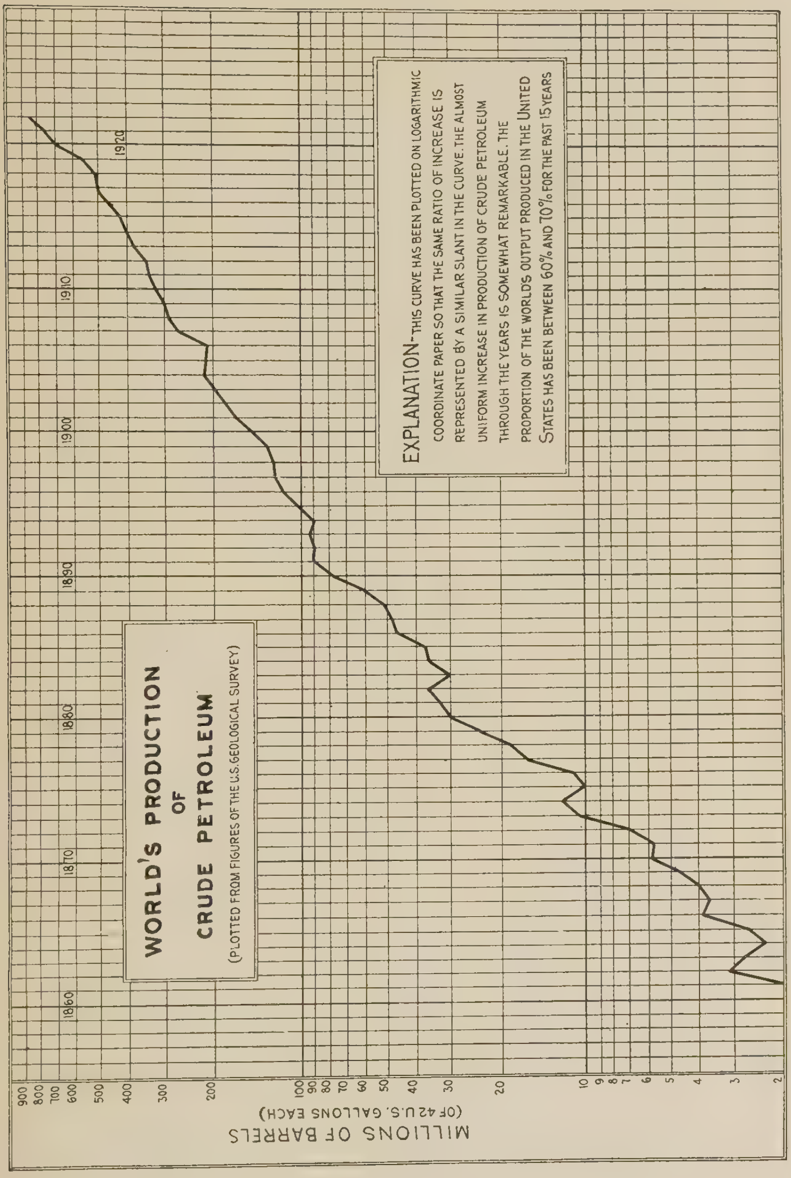
Similar eruptions have occurred before, and it has been reported that rivers of oil have emerged from beneath the Caspian Sea.

In one case a navigator related that for several minutes his vessel was afloat in oil.

Distribution of World's Resources.—Geographically oil is found in all of the continents in considerable quantities, but to date the greater part of the world's production has been obtained in the Americas. During the past 65 years, according to the United States Geological Survey, oil has been produced in the world to a total of some ten billion barrels of 42 U. S. gallons each, approximately 62 per cent of which has been produced in the United States. The following table will serve to give some idea of the relative production of the different oil fields of the world:

World Production of Petroleum

Country	Year 1922		Period from 1857 to 1922	
	Thousands of barrels	%	Thousands of barrels	%
United States	557,531	65.2	6,459,582	62.3
Mexico	182,278	21.3	912,199	8.8
Russia	32,966	3.9	1,965,955	19.0
Persia	21,909	2.6	89,581	.9
Dutch East Indies	16,720	1.9	253,341	2.4
Roumania	9,843	1.2	183,672	1.8
India	7,700	.9	139,895	1.3
Peru	5,314	.6	38,810	.4
Poland	5,227	.6	179,574	1.7
Argentina	3,018	.4	12,286	1.4
British Borneo (Sarawak)	2,849	.3	8,402	
Trinidad	2,445	.3	16,156	
Venezuela	2,201	.3	4,969	
Japan and Tiawan (Formosa)	2,042	.2	47,230	
Egypt	1,188	.3	9,582	
France (Alsace)	496		1,941	
Colombia	323		323	
Germany	319		15,987	
Canada	179		25,230	
Czecho Slovakia	120		331	
Italy	31		1,107	
Algeria	9		50	
England	1		9	
Other	100		566	
Totals	854,809	100.0	10,366,778	100.0


WORLD'S PRODUCTION OF CRUDE PETROLEUM

(PLOTTED FROM FIGURES OF THE U.S. GEOLOGICAL SURVEY)

EXPLANATION-THIS CURVE HAS BEEN PLOTTED ON LOGARITHMIC COORDINATE PAPER SO THAT THE SAME RATIO OF INCREASE IS REPRESENTED BY A SIMILAR SLANT IN THE CURVE. THE ALMOST UNIFORM INCREASE IN PRODUCTION OF CRUDE PETROLEUM THROUGH THE YEARS IS SOMEWHAT REMARKABLE. THE PROPORTION OF THE WORLD'S OUTPUT PRODUCED IN THE UNITED STATES HAS BEEN BETWEEN 60% AND 70% FOR THE PAST 15 YEARS

Fig. 1.

The accompanying chart (Fig. 1) shows the world's production by years, in barrels, during the same period.

Sources of Petroleum.—There has long been entertained a popular belief that oil is obtained from vast subterranean lakes. Strictly speaking, this idea is erroneous, for, while many underground pools do exist, the greater part of the production comes from saturated sands, limestones, and shales.

Both oil and gas are migratory, the natural actuating forces which cause oil to move through its embodying element being gas pressure, capillary attraction, encroaching water, and gravity. It frequently happens that valuable oil lands are made practically worthless through the drainage of the reserves by wells even a considerable distance away. Where oil properties are divided into small tracts owned by different individuals and containing only a few acres each, wells have frequently been drilled in haphazard fashion, each operator being anxious to raise as much oil as possible within the limited time at his disposal. It is interesting to note that in the townsite of Burkburnett, Texas, and at Long Beach, California, as many as three or four wells have been drilled to the acre. The wells at Balakhani and Bibi-Eibat (Baku) are also closely spaced. Manifestly, this practice is very wasteful, requiring several times as much expenditure as is necessary to produce the recoverable oil.

Of course, the nature of the forces bringing about a particular condition in an oil well are often a matter of pure conjecture, but the fact has been established that there is a distinct relation between the decrease in gas pressure and the decline in flow of oil. A rapid decline in gas pressure reduces its expulsive effectiveness, and close well spacing has the tendency to accelerate pressure decline in a field. It follows, therefore, that closely spaced wells are an economic as well as a financial extravagance.

The geologic structures in which oil and gas in quantities sufficient to justify commercial exploitation are most frequently found are anticlines, synclines, domes, and faults. Usually water occupies the lower portion of the strata, oil overlies the water, and gas is found in the upper portion. A great deal of credit is due professional geologists, and especially the United States Geological Survey, for the store of scientific knowledge which their efforts have accumulated for the industry, and numerous excellent technical papers can be obtained from the Government Printing Office in Washington at very modest prices.

PART I

PRODUCTION

CHAPTER I

AN OUTLINE OF OIL-FIELD PRACTICE

The organization of an oil company differs in no particular respect from that of any other enterprise, though its very speculative character seems to enhance the value of an oil stock in the eyes of the investing public. It is hardly necessary to mention that millions have been lost to investors in "wildcat" oil companies, or that many oil-company promoters had not the slightest intention of ever coming within a hundred miles of an oil field. In fact, actual instances are on record in which the cash received for the sale of capital stock was considered to be an item of income from which it was necessary only to deduct salaries and office expenses in order to determine net profits available for *distribution to the promoters.* The recent indictments and convictions at Forth Worth should do much toward curbing such illegal activities, for, since the entire proceeding was in the hands of Federal authorities, an appropriate sentence was given each promoter whose dealings did not withstand the most critical inquiry.

Acquisition of Properties.—Oil freeholds and leaseholds, as well as royalty interests, are the subject of much barter, and as a result two new pseudo-professions have arisen. Those following these *professions* are known as "oil-scouts" and "lease-hounds." The oil-scout, usually in the employ of a large company, follows up rumors of oil strikes and endeavors to obtain options upon the most valuable rights before the customary rush to the locality begins. His task is a difficult one, requiring sharp wits and unusual training, and his creed is that all is fair in love and war—*and lease buying.* The lease-hound, the second of these professionals, usually operates on his or her own account, acting as an intermediary between the lease owner and the prospective buyer, and charging as a commission all that the transaction will bear.

Some astonishing tales of sharp dealing, as practiced by the oil-scouts and lease-hounds, may be heard in the oil fields. In one instance a farmer, aware of the potential value of his property, demanded $50,000 for a very desirable 50 acres. Several lease-hounds had bargained with him, each using all the persuasive arguments at his disposal, but all to no avail. Finally, so the story goes, an especially enterprising young man agreed to pay the required price. But, he explained to the farmer, the real value of the land was contained in the southwest 10 acres, the other 40 acres merely being so much dead weight, as far as his company was concerned. Under the circumstances, however, the company felt that $50,000 was a fair price, and was entirely willing to pay that sum in order to obtain the property. Since the 10-acre tract was the objective, he explained, he would make out a sight draft on his company for $40,000 covering that portion of the property. For the remaining 40 acres he would immediately pay $10,000 in cash, thus making $50,000 for the entire 50 acres. The farmer agreed to this arrangement; separate deeds were drawn, one covering the 10-acre tract and the other the 40 acres, and the deal was consummated. Unfortunately, the sight draft was refused by the drawee, and the farmer was surprised to find that he had sold 40 acres of very valuable land for only $10,000.

In acquiring leaseholds the purchaser generally pays an initial bonus, and agrees to pay an annual rental of a stipulated amount per acre until the lease is developed. The prompt payment of this rental is very important, since in many instances the lessor is only too anxious that the lessee default in the payment of the rental, thus releasing him from his contract. This is especially true where the landowner has entered into an arrangement which subsequent events have shown to be unfavorable, and where an opportunity has presented itself to collect a much larger bonus from other prospective purchasers.. In order to obviate the necessity for locating the lessor at each rental date, leases generally provide that the rentals when due be deposited to the credit of the lessor in a designated bank. After a lease is developed the lessor usually receives a fractional royalty of the *oil and gas saved*, together with any gas which he may require for domestic purposes.

Leases of Indian lands must be approved by the Department of the Interior, and in the cases of the Osage Nation and the Five Civilized Tribes, all transactions are under the supervision of the resident Indian Agent. The interests of the Osage Nation are probably the most valuable tribal rights in the world. In 1905 each member of the tribe then living was allotted an equal share of the tribal holdings; these shares cannot be assigned, transferred, or sold, and can only change hands by inheritance. Income from bonuses, royalties, surface rights, etc. is divided among the members of the tribe annually according to shareholdings. In the case of *restricted* members, those incompetent to manage their own affairs, only a portion of the income is actually paid the Indian, the balance being accumulated to his credit.

Considerable caution should be exercised in perfecting titles to oil properties, as a surprising number of claims have been filed against valuable properties in the titles of which there existed only a slight flaw. In the famous Tommy Atkins case in Oklahoma at least four individuals were produced, each being represented to be the only and original Tommy Atkins.

In order to allow time to perfect a title, and at the same time make sure that no other operator procure the property during the intervening period, properties are frequently sold under option. These options are entered into through *escrow agreements,* under which the prospective purchaser deposits an agreed part of the purchase price in a particular bank. The agreement usually provides that should the purchaser fail to buy after a clear title has been established, the deposit be forfeited.

Another common manner of paying for oil properties is that by which an initial down payment is made at the time of the execution of the deed and the remainder of the purchase price is to be paid from the proceeds of oil produced.

Most successful oil companies now recognize the value of the services of petroleum geologists in purchasing properties, as well as in selecting locations for wells. A great many companies maintain a geological department and rely in a large measure on its advice in their operations.

Development.—The development of an oil or gas property is an expensive undertaking, and the cost varies considerably according to local conditions and circumstances. The most advantageous time for beginning development work must be determined by the management. A number of factors will influence their decision; among these are:

1. Financial condition of the company.
2. State of development of surrounding properties.
3. Marketing facilities in the locality.
4. Market price for crude oil.
5. Weather conditions.

If adjacent properties are in process of development, it may be imperative that drilling be commenced at once in order to protect the company's oil reserves against drainage. The recent controversy anent the propriety of leasing the Naval Oil Reserves at Teapot Dome to private interests arose in this connection. The practice of drilling to protect reserves against drainage is quite common, and is termed *offsetting*. It is generally understood that a well drilled 300 feet or less from a property line must be offset, and most leases make such offsetting mandatory on the lessee.

As regards marketing facilities, purchasing companies will usually arrange for the extension of a gathering line to the property where the oil is being produced. Of course, if the property is being developed by a company which has its own pipe lines and refineries, the problem is merely one of the extension of its line.

The condition of the crude-oil market always has a marked influence on development work, especially in the case of the independent producer. Large companies are in a somewhat different position since they can use the oil in their own refineries or store it, as they see fit.

Drilling.—Drilling is undertaken, sometimes by the company's own drilling rigs, in other cases through drilling contractors. Drilling contracts may take any of several different forms. Many small producers let what are known as "fifty-fifty" contracts in which the contractor's compensation is usually an undivided half-interest in the property. It may be well to note here, parenthetically, that there is considerable difference between an *undivided* half-interest in a property, and a half-interest. In the first case the purchaser will acquire one-half of the working interest (after deduction of royalty), while in the latter case he will acquire title, in fee or by lease, to one-half the acreage involved. In other words, an undivided half-interest indicates a one-half interest in the whole working interest, while a straight one-half interest makes necessary the transfer of title to certain specified land.

Another kind of contract frequently found is the so-called "Turnkey Job." Here the drilling contractor usually furnishes everything necessary to the drilling and completing of the well and, for a fixed compensation, turns over to the producer either a completed well or a dry hole.

In the event that the company decides to do its own drilling, either a portable drilling rig is moved to the selected site, or a derrick is erected thereon. Portable rigs are frequently used to a depth of 1,500 feet, but for greater depths a more substantial derrick is required. There are a number of drilling systems in use throughout the world; the system to be used in a particular case depends upon the formations to be penetrated, the probable depth of the well, and other factors. Some of the systems in use are as follows:

PERCUSSION SYSTEM

American Cable	United States and Roumania
Canadian Pole Tool	United States, Canada, Russia, Roumania, Galicia, and New Zealand
Fauck's Freefall	Russia
Russian Freefall	Russia, Burma, and Java
Wire Rope	United States and Canada

ROTARY FLUSH SYSTEM

Calyx Drill	United States
Diamond Drill	United States
Fauck's Rapid System	Galicia and Roumania
Parker Drill (Mud Flush)	Russia, Trinidad, United States, Borneo, Sumatra, Java, Burma, Nigeria, and Mexico.

The rotary system, which is used where soft, caving formations may be encountered is, in most cases, considerably more expensive than the percussion system, used for hard formations. Drilling costs range from as little as $1 per foot to as much as, and sometimes more than, $50 per foot.

Drilling crews work in shifts, called *tours,* usually of 12 hours each. Some wells are completed in 2 or 3 weeks, others may require many months. The time required to complete depends upon the depth to the producing sand, the composition of the formations penetrated, the skill of the crew, weather conditions experienced, and drilling troubles. In many cases drilling tools are dropped in the hole, and weeks are often consumed in fishing them out, or breaking them up. In the case of contract drilling, the time during which the crew is idle, if through no fault of the contractor, is charged as *shut-down time,* at the rate of about $100 per day.

As drilling progresses, record is kept of the various formations through which the tools pass. Accurate information is difficult to obtain, especially with the rotary system of drilling; a number of cases are on record where rich sands have been drilled through with a rotary drill, without the presence of oil being discovered. The *well log* later becomes an important part of the company's records, furnishing as it does important geological data upon which to base the future drilling operations.

As the hole becomes deeper, casing is lowered and cemented in place, and when the drilling is finally completed the resultant oil or gas well is connected up to oil or gas lines. If oil or gas is not encountered, as much as possible of the casing and other equipment is salvaged, and the well abandoned. Under the laws of most of the states, it is then necessary to plug off the water sands, and a state inspector's certificate is usually required. The purpose of plugging a well is to prevent the flooding of oil and gas sands with water; several fields have been almost ruined through the failure of operators to plug abandoned wells properly.

Well Operation.—Three different products in varying quantities may be obtained from an oil well. The most important is, of course, oil. As explained above, the well is connected with a flow line; this line conducts the oil into a settling tank. Here the water and solid matter are allowed to settle to the bottom of the tank, after which the oil is pumped into the lease storage tanks. Where the oil and water are so closely associated that they form an emulsion, dehydration may have to be resorted to; this subject is dealt with in more detail in Part II of this volume.

Casinghead gas, the second product obtained, is the gas which overlies the oil in the deposit and it has a large gasoline content. It is generally believed that the release of pressure caused by the penetration of an oil stratum has the effect of releasing from the oil many of the lighter elements, thus increasing considerably the amount of gas as well as its gasoline content. It is the gas pressure which causes a well to flow. In modern practice, the gas is turned into separate lines, and later a gasoline of a very high Baumé gravity extracted therefrom. For an outline of casinghead plant operation, see Part III.

It may be of interest to mention that a number of very serious accidents have occurred as a result of the failure to take the necessary precautionary measures in the handling of casinghead gasoline. The Bureau of Explosives has promulgated safety regulations for the loading and unloading of inflammable liquids.

The following is a list of the casinghead gasoline accidents which have occurred in the United States in recent years:[1]

Location	Date	Number killed	Number injured	Property loss
Memphis, Tenn........	Jan. 24, 1921	13	18	$ 150,000
Ardmore, Okla.........	Sept. 27, 1915	47	524	1,054,000
Saint Louis, Mo........	Apr. 22, 1911	8	7	2,100
Leach, Ky.............	Dec. 31, 1918	5	1	
Atlanta, Ga...........	Feb. 12, 1918	2	11	5,500
Toledo, Ohio..........	Apr. 22, 1911	2	3	1,000
West Tulsa, Okla......	July 31, 1919	1	18	10,200
Gainesville, Tex........	May 18, 1917	1	4	36,000

A certain quantity of the original casinghead gas remains after the extraction of the gasoline, and this dry gas constitutes the third product obtained from an oil well. Dry gas is generally used or sold for fuel purposes, although it is sometimes allowed to blow off to waste.

In case the gas pressure in the well is not sufficient to cause a natural flow, it becomes necessary to pump the oil. It frequently happens that *squibbing*, that is, exploding a charge of nitroglycerine in the oil sand, must be resorted to in order to bring about a flow of oil, and this notwithstanding gas pressure. Squibbing is necessary where the sand is closely packed and tight grained. However, the gas pressure may not even then be sufficient to produce a flow, in which event pumping must be resorted to. The original derrick, in the case of deep wells, is often left standing, and the walking-beam utilized to pump the well; in the case of shallow wells a *pumping-jack* is set up and connected with an engine, motor, or central power station. The last method is very economical where there are a number of wells on a property, since all of the wells may be connected to the central power station by means of pull-rods.

In addition to the several oil fields in the United States, there are also a number of districts producing gas only. It is generally believed that at some earlier period oil was present in these fields, but that the embodying sand was of such a texture that the oil has gradually drained away. The procedure in drilling for gas differs in no material respect from that employed in prospecting for oil, but the production and marketing of gas constitute an industry entirely separate from the oil industry.

---

[1] Cross, Roy, *Bull.* 16 of Kansas City Testing Laboratory.

In the case of gas wells with varying pressures connected to the same line, it is sometimes necessary to cut down the pressure of one or more of the wells in order to equalize to the line pressure. This is done by means of a *Christmas tree*, so called because of its shape, an arrangement of master gate valves, bradenheads, etc.

Grading of Petroleum.—Crude petroleum and its products are graded according to their gravity in degrees Baumé, and the presence of sulphur and emulsified salt water in the oil may also affect its grading. The following are conversion formulæ for converting specific gravity into Baumé degrees, or vice versa:

$$\text{Specific Gravity} = \frac{140}{\text{Degrees Baumé} + 130}$$

$$\text{Degrees Baumé} = \frac{140}{\text{Specific Gravity}} - 130$$

These formulæ are based on a standard temperature of 60°F., and corrections must be made if the temperature of the oil is more or less. Tables for the adjustment of actual gravities and volumes at varying temperatures to corrected readings at 60°F. will be found on pages 68 and 69.

CHAPTER II

ACQUISITION OF OIL AND GAS PROPERTIES

When oil or gas lands are acquired, one or more of several conditions may obtain. In the first place the property may be fully developed, or it may be entirely undeveloped. In the second place the interest acquired may be either freehold, leasehold, or royalty. Third, the amount of the purchase price may be definitely fixed, as in an ordinary purchase, or it may be dependent upon the future performance of the property. For example, the most common of these contingency agreements is that under which the buyer agrees to pay a specified amount at once, and an additional sum from the proceeds of oil and/or gas produced; should such production fail to be obtained the remaining payments will be automatically canceled.

Acquisition of Undeveloped Properties.—When a company acquires undeveloped acreage, the usual expense incident thereto will include traveling expense, geological expense, attorney fees, abstract fees, etc. All of these necessary expenditures should be capitalized, constituting as they do a portion of the cost of the property. A *Lease Record—Index Sheet* (Form 1, page 84) has been designed for keeping in a subsidiary book a complete index of all properties owned by the company, both oil and gas. The *Lease Record for Producing Properties* (Form 2, page 85) is corollary to Form 1 and is so arranged that all subsequent development, tangible and intangible, will be included therein. By the use of these two forms for each oil or gas property, whether freehold, leasehold, or royalty interest, a complete history of the property is readily available. It is, of course, understood that the Lease Record for Producing Properties will not be used for any particular property until development work begins.

Forms similar to those presented here are being used by a number of the more important producing companies, with very satisfactory results. The reader will do well to familiarize himself with each of the forms as it is discussed in the text, as well as with the Classification of Accounts at the end of Chap. IX (pages 82 and 83).

The purchase price, usually the bonus paid, together with all expenditures incidental to the acquisition of undeveloped acreage, should be charged to the general ledger account *Undeveloped Properties.* A Lease Record—Index Sheet should then be opened for the property, and all of the information for which space has been provided entered thereon; this information will include the lease number, name of lease, acreage, as well as all the descriptive data included at the head of the form. Each lease should be assigned a number, and the lease agreements bearing these consecutive numbers should be filed in rotation. In connection with the lease numbers it is often found convenient to designate properties in different states by prefixing an appropriate letter. For example, the letter "O" might be used for properties in Oklahoma, "T" for properties in Texas, "C" for California, and so on. Needless to say, the Rental Record (see Form 1) must be carefully kept, since this part of the information is often of the gravest importance, as previously pointed out. The Well Record, together with the Well Location data on the back of the form, will not be filled in until development begins on the property.

Acquisition of Developed Properties.—As in the case of undeveloped properties, the entire purchase price of properties already developed, including all miscellaneous expense in connection therewith, should be capitalized. Charge should be made to the general ledger account *Producing Properties* for the purchase price of the property, excluding the cost of development and equipment. The lease equipment should be properly subdivided, as to the portion of the purchase price applicable thereto, into the following classifications:

Derricks,
Casing, tubing and rods,
Pumping equipment,
Line pipe and fittings,
Tanks,
Other equipment.

The total of the equipment should be charged to the general ledger account *Lease Equipment.* Development cost (intangible) should be charged to the account *Development.* Both of the Lease Record forms should then be opened for the property, and the information concerning wells, lease equipment, etc., entered up. It will be noted that four of the property accounts in the general ledger are supported by the detailed information furnished by the Lease Record; these accounts are

Undeveloped Properties,
Producing Properties,
Development,
Lease Equipment,

and it is, of course, understood that where development is commenced on a property, a journal transfer entry should be made between the respective general ledger accounts.

As the procedure in the case of the acquisition of either a freehold interest, a leasehold interest, or a royalty interest is essentially the same, only a few special points need be mentioned. Where a company is interested in a large number of properties, it is advisable to subdivide the subsidiary property record so as to group each type of the company's holdings separately. This is merely for bookkeeping convenience.

In the case of a *partnership lease* care should be taken, in entering up the Lease Record, that the company's interest is accurately described, as for instance, "undivided one-half of seven-eighths working interest." Under a partnership lease, the usual procedure is for one company to develop and operate the lease, invoicing the other company for its proportion of the expenditures.[1] Perhaps the best method is to enter the full purchase price of the entire lease and of the equipment, in the regular manner in the Lease Record, and to enter, as a red ink deduction, the other company's proportion. This seems the preferable method for handling partnership accounts, although no serious objection can be advanced against charging into the subsidiary records only the proportion of the working interest owned.

Special Purchase Agreements.—Usually, oil properties are purchased for an agreed price, though the method of payment may vary, as in the case of a *purchase under escrow agreement.* Here the prospective purchaser places a specified sum in escrow, usually with a bank or trust company, awaiting the perfecting of a clear title. This sum should be charged to the general ledger account *Cash in Escrow* until the transaction is completed, after which it should be charged to the proper capital asset account. If for any reason the amount be forfeited, a special charge against income should be made.

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[1] It may be mentioned that it is a matter of the very greatest importance that monthly statements be rendered to the other partner, by the company operating the property; and that the correctness of the statement should be acknowledged by the other partner within a reasonable time. Invoices supporting expenditures should be obtained in duplicate and these duplicates should accompany the statement to the other partner. Many of the larger oil companies have had the bitter experience of serious disputes and costly litigation in cases where accounts were not regularly settled as rendered.

Agreements providing for part of the purchase price to be paid out of oil and/or gas produced, are not so simple of treatment in the accounts. At the outset two distinct conceptions of a transaction of this nature present themselves. First, we may consider the matter as an ordinary sale, with only a special method for payment of the purchase price. Here our greatest problem is that of determining the exact purchase price, as this is dependent upon one of two events which may happen in the future. If the property becomes exhausted before the agreed balance is paid off, it is usually provided that the unpaid remainder be canceled.

Second, the vendor is considered to be selling only certain anticipated future production for the initial payment, and to be retaining the oil reserves the proceeds from which are to be paid over to him under the agreement. The wording of the agreement of sale will ordinarily indicate under which of these two classes of transaction the sale belongs. Our problem, therefore, may be stated as that of determining a correct purchase price, and of properly recording such price in the accounts. Conservative practice dictates the best method is that of setting up as an asset the full purchase price of the property, crediting the difference between the cash payment and the agreed-upon price to an account captioned, say, "Purchase Money Obligation, Payable from Proceeds of Oil Produced." The production from a lease purchased under such an arrangement is income, differing in no way from the income from any other property. The alternative, and less desirable, method of handling such a transaction is to set up the initial payment as an asset, and to capitalize each additional payment only as and when it is made.

CHAPTER III

DEVELOPMENT OF PROPERTIES

The development of oil properties is an expensive undertaking; in the California and Wyoming fields it is not unusual for a well to cost from $100,000 to $250,000. The following cost of a representative 3,000-foot well, drilled during the year 1923 in the Burbank field of Oklahoma, is of interest:

Standard rig, complete with cellar		$ 3,800.00
Drilling contract at $3.50 per foot		10,500.00
Casing:		
20 feet of 20- inch at $7.83	$ 156.60	
950 feet of 15½-inch at 5.49	5,215.50	
1,350 feet of 12½-inch at 3.07	4,144.50	
1,700 feet of 10- inch at 2.41	4,097.00	
2,350 feet of 8¼-inch at 1.65	3,877.50	
2,950 feet of 6⅝-inch at 1.35	3,982.50	21,473.60
Casing shoes		122.70
Casing clamps		49.50
Miscellaneous fittings		20.00
New tank, complete		235.00
1,500 feet of water and gas line at 22½ cts		337.50
80 days gas at $25		2,000.00
80 days water at $10		800.00
Teaming		1,200.00
Labor		600.00
Total cost		$41,138.30
Casing salvaged		13,000.00
Net cost of producing well		$28,138.30

NOTE: If this had been a dry hole, there would have been further salvage of possibly $4,000, so that the cost of a dry hole in this field would approximate $24,000.

Authorizations.—When in the judgment of the management the proper time has arrived for drilling a well, the various reports from the geological, engineering, and operating departments should be gathered together to form the basis for two *Authorizations*, one for the drilling and the other for the equipping of the well. The authorization for an oil company is similar to the

Work Order or Job Order in a manufacturing concern and to the A.F.E. (Authorization for Expenditure) used in railroad accounting. No special form is suggested in this connection, but a list of the information that should be set out therein is dealt with later, in Chap. IX (page 79).

Recording Development.—After development work has been started, a sheet should be opened in the *Wells and Construction in Progress Record* (Form 9, page 92) for each new well. This form has been designed with a view to providing for all essential information concerning the cost of development work done by the company; a special effort has been made to avoid the common error of unnecessary detail. All expenditures on uncompleted wells, as well as on general lease equipment not applicable to any specific well, are controlled by the two general ledger accounts *Wells in Progress* and *Uncompleted Lease Equipment.* As each well is completed, the total cost should be transferred to the appropriate general ledger classification, and the totals carried into the subsidiary Lease Record (Form 2). In the case of a dry hole, the recovered salvage should be entered in red ink as a credit against the cost of the well, and the net loss charged to *Dry Holes* in the general ledger.

When a new well is contemplated, the usual operating procedure is for the engineering and geological department to examine the property to be drilled, and to select a suitable location for the well. If the company is operating its own drilling tools, the drilling department is then notified and work commenced almost immediately. A great many companies find it profitable to let certain contracts to regular drilling contractors rather than to have the work undertaken by their own department.

All expenses in connection with the work of selecting a site for the well should be charged to *Development,* as also should expenditures for intangibles; these intangibles may be shown in the Wells and Construction in Progress Record in considerable detail, should the management require a complete analysis.

If a drilling contract is entered into with a regular contractor, the company should insist that complete information as to dates, formations penetrated, etc., be furnished. In the case of a turnkey job (where the contractor supplies everything and turns over a completed well or a dry hole) very little accounting difficulty should be encountered. Sufficient details must be obtained from the contractor, however, in order that the accounting department be enabled to divide the contract price properly, as between development costs of an intangible nature, and the different classes of physical equipment.

If the company undertakes the drilling work through its own drilling department, charges for work done on each well should be kept separately by that department. The classification of accounts here presented has been so designed that all the expenses in connection with well drilling are charged to a service division termed "Drilling Department"; and on the basis of reports furnished by the department, this account will be closed out periodically to the wells benefiting. Any burden which cannot be directly allocated to specific wells, should be apportioned on the basis of drilling days.

The treatment in the accounts of development expense will differ according to the policy of the company. The best practice is that of capitalizing all development costs and then amortizing such costs over the productive life of the property, by means of depletion charges. This method of treatment has the advantage of apportioning against the income of each accounting period a ratable share of the development expense.

Intangible Drilling Treated as Expense.—Under the United States income and profits tax laws (which are discussed in more detail in Part V), the producer was given the option either of capitalizing the intangible drilling expenses or of charging them off to expense, as long as he was consistent in his method from year to year. The natural result was that a large number of companies then instituted the practice of charging off the intangibles (mainly in order to save taxes); and though there is no denying that this practice is conservative, or even ultra-conservative, the result is likely to be that the operating results are distorted and that the earlier years of the company's development history are burdened with undue expense.

Wells and Construction in Progress Captions Discussed.—In connection with closing out Wells and Construction in Progress to the respective general ledger control accounts, as well as to the subsidiary Lease Record classifications, it may be in order to indicate in a general way the items which should be included under each caption.

As previously stated, *Wells in Progress* should include, besides the regular costs of drilling, all the initial expenditures of the engineering and geological departments in choosing a suitable location for the well. Taking the representative well in the Burbank field at the beginning of this chapter as an example, the drilling costs will include:

Amount of drilling contract,
Gas,
Water,
Teaming, and
Labor.

Derricks should include the cost of material used in their construction, together with the labor and miscellaneous expense of erection. In the event, however, that the company elects to charge off development expense as incurred, labor and expense should be transferred to a profit and loss account captioned Intangible Development Expense and only the actual material cost of the derrick capitalized. Where the derrick is erected by a contractor on a turnkey job, or by a rig-builder, the elements of cost should be separated and charged as above indicated; this applies, of course, only where the company pursues the policy of charging off development expense.

Casing, tubing, and rods should represent the total cost of this class of equipment, including labor of setting, etc., and miscellaneous expense. As above explained, expenditures of an intangible nature may be charged to profit and loss at the company's election. It should be noted that provision has been made in the subsidiary records under casing, tubing, and rods, for size and length, as well as cost. This information often is of importance, and should be as carefully preserved as is that concerning cost.

Pumping equipment should be charged with the equipment used in pumping the completed wells, and in the company's discretion may include such items as adjusters, polished rods, stuffing boxes, working barrels, valve-rods, etc., as well as pumping powers, pull-rods and cables, pumping-jacks, etc. No attempt has been made in the classification of accounts to separate well equipment from general lease equipment, but should the pumping equipment be installed for a specific well, it should be so designated both in the Wells and Construction in Progress Record and in the Lease Record.

Line pipe and fittings should include all oil, gas, and water lines on the lease, but will not be charged with any equipment in the nature of casing, tubing, etc., elsewhere provided for.

Tanks account should include the cost of all tanks on the lease, except where the company maintains a separate storage department; in this event it may be desirable that all tanks used for other than temporary storage be included in the accounts of that department. This is largely a matter to be decided according to the operating requirements of the company.

Other equipment should be charged with all lease equipment not otherwise provided for under separate classifications, and is discussed in more detail in Chap. V.

Other uncompleted construction will include all fixed assets, the property of the company, which are not attached to any particular lease, such as:

Permanent buildings,
Temporary structures,
Drilling equipment,
Machine-shop equipment,
Water wells,
Telephone and telegraph facilities, etc.

A suggested card record of these assets is discussed in a later chapter.

CHAPTER IV

DEPLETION OF PROPERTIES

The subject of depletion is a broad one when considered in all its aspects, and it has of recent years claimed the attention of a number of industries in connection with tax legislation. In this chapter it is proposed to deal with depletion only as it affects the accounts of an oil company and for this purpose depletion may be concisely defined as: *The amount by which the value of a property is reduced through the extraction of its oil or gas resources.*

Nature of Depletion.—In the operation of an oil property depletion is an ever-present factor, and attaches to each unit of oil or gas produced. Just as there is a certain definite quantity of oil or gas which is commercially profitable to produce, so the capital value will be reduced dollar by dollar as the production continues.

Actually, of course, the theory is somewhat erroneous for various reasons touched on in an earlier chapter, as for example the migratory characteristics of oil and gas; but for practical purposes it has been found to be the most convenient and workable basis.

Strictly speaking, depletion is not an expense; neither is it entirely analogous to depreciation, though it is often so considered. It is more nearly comparable with the *Cost of Goods Sold* of manufacturing industries, than with any other item of deduction from income. In fact, to the oil industry, depletion really *is* cost of goods sold, as it constitutes a lessening of available reserves. These reserves are an oil company's stock-in-trade, since lifting expense, analogous to manufacturing expense, must be incurred before the product is ready for market. Where the manufacturer or jobber would credit Inventories of Merchandise and charge Cost of Goods Sold with the inventory value of goods disposed of, the oil operator will charge Depletion Sustained and credit Depletion Reserve with the cost of the oil extracted.

Depletion for accounting purposes falls naturally into two main divisions:

1. Depletion of cost,
2. Depletion of excess of book values over cost;

and under the latter category there are two subdivisions which are important in connection with the Federal tax laws, according to whether the book values have arisen from revaluations as at Mar. 1, 1913, or as a result of what is known as *discovery*.

Depletion of Cost.—In order that depletion may be computed with reasonable accuracy, it is necessary that two figures be known as nearly as possible, namely, the cost of the property and the available oil and/or gas reserves. The cost of the property is readily determinable and, as explained in Chap. II, will include the initial bonus paid, whether this payment were made outright or under some special arrangement of deferred installments, and all expenditures for traveling, geological fees, etc., directly incidental to the acquisition of the property.

Intangible development expense, as previously stated, may either be capitalized or, if the company so elects, charged off as an expense. The cost of the property, then, will include:

Initial bonus.
Incidental expense of acquisition.
Intangible development expense (when capitalized).

The ascertainment of the available oil reserves is not nearly such a simple problem but, given certain accurate data, an estimate that will approximate true conditions is entirely possible.

Determination of Oil Reserves.—In estimating the underground reserves a great deal of useful information may be obtained from the *Manual for the Oil and Gas Industry*, published by the Treasury Department, United States Internal Revenue. In that manual there are set out exhaustive data concerning most of the pools and sands of the United States.

Experience in the cases of a large number of wells has gone to prove that the periodic production from a given sand will diminish in regular geometrical ratio from month to month. The estimate of the future production of a well should therefore be based on its past performance, where such information is available.

There are, of course, a number of circumstances that will tend to obscure the regular production trend. In the first place, most wells, especially in new or only partially developed fields, come in with what is known as *flush* production. Flush production appears to be the result of the blowing off of accumulated underground pressure from cavities or loose formations in the immediate vicinity of the well. This flush production may last from an hour or two to several months, after which a more settled production may be expected. Other causes which may tend to obscure the production trend are due to the operator's own methods, such as shooting and swabbing, and also to the close spacing of wells, use of compressed air, vacuum pumps, etc.

In order to insure reliable estimates, the production of a lease should be plotted on coordinate paper, using the average number of barrels per well each month, as a basis for the curve.

It has been the custom in the past, by most oil operators, to use *arithmetic* coordinate paper for plotting production curves, so that a reduction of a certain number of barrels in production will be represented by the same vertical space on the chart. During the last year or two the *geometric* or *logarithmic* coordinate paper has gained in favor, and will probably continue to do so as its properties become better understood. The same proportionate decrease in production on logarithmic coordinate paper, will be represented by the same vertical space on the chart; the production *curve* of a lease on this paper should therefore be represented by a *straight line.*[1]

On Fig. 2 has been plotted the production of an actual lease in Oklahoma, picked at random. A lease with a large number of wells has intentionally been selected so that flush production on any new wells, or swabbing, etc. on any of the old wells, will not be likely materially to affect the result. In the illustration the black curve has been plotted on the basis of the arithmetic scale to the right of the illustration; and the dots enclosed in the two parallel lines represent the same production based on the logarithmic scale to the left. It will be seen that, with very few excep-

[1] Logarithmic coordinate paper, of suitable proportions for our purpose, is not easily obtainable. Perhaps the best standard form would be a scale of three banks with sufficient space horizontally for recording the monthly production for ten years. Such a form will be found reproduced on the reverse side of Form 10, p. 94. The original drawing was made to fit the back of a 11- by 17-inch loose-leaf sheet. The months were one-tenth of an inch each, and each bank of the logarithmic scale was 3 inches high, the measurements for the intermediate numbers being obtained by multiplying the logarithm mantissa of each number by three. It will therefore be seen that, with the help of a table of logarithms, the construction of a logarithmic scale of any dimension is a perfectly simple matter.

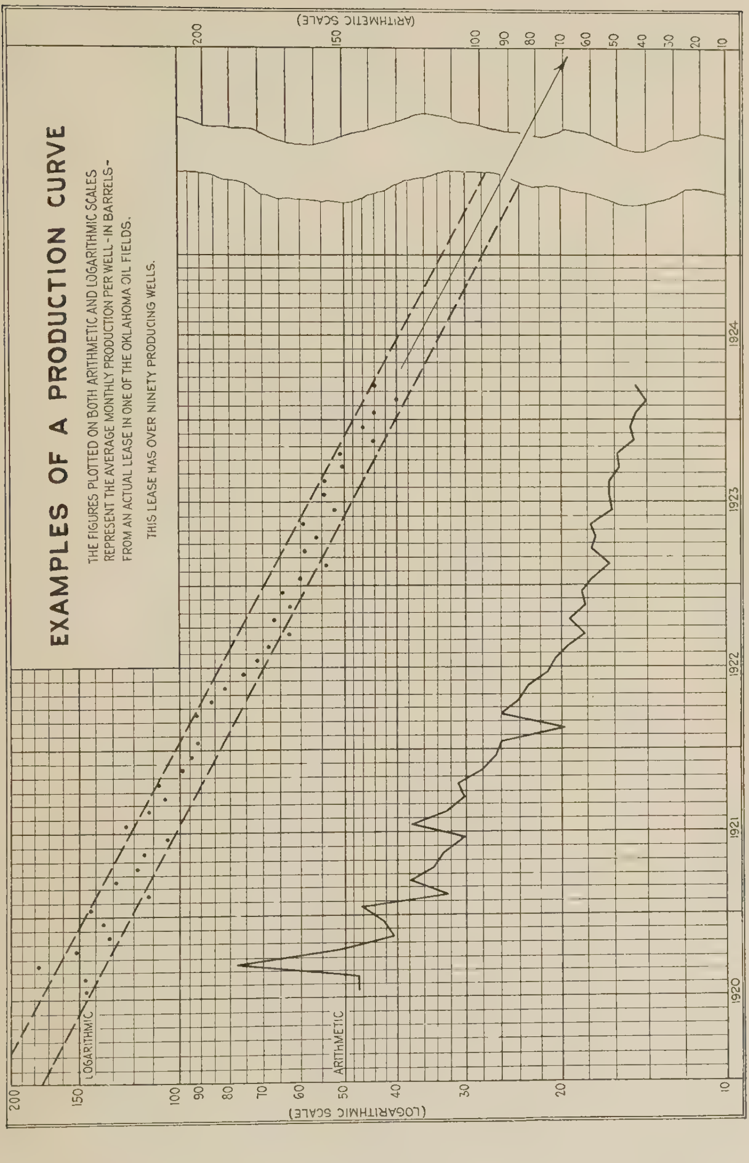
EXAMPLES OF A PRODUCTION CURVE
THE FIGURES PLOTTED ON BOTH ARITHMETIC AND LOGARITHMIC SCALES REPRESENT THE AVERAGE MONTHLY PRODUCTION PER WELL - IN BARRELS - FROM AN ACTUAL LEASE IN ONE OF THE OKLAHOMA OIL FIELDS.
THIS LEASE HAS OVER NINETY PRODUCING WELLS.
(ARITHMETIC SCALE)
200
150
100
90
80
70
60
50
40
30
20
10
(LOGARITHMIC SCALE)
200
150
100
90
80
70
60
50
40
30
20
10
LOGARITHMIC
ARITHMETIC
1920
1921
1922
1923
1924

FIG. 2.

tions, the production plotted on the logarithmic scale lies within a narrow strip, which for the sake of clarity has been enclosed by the two parallel lines. If the space between these lines is bisected, the resultant central line, when projected to the right, will give a reasonably accurate forecast of the future production. A similar average *curve* can be made through the black arithmetic curve shown, but the reader will find by experiment that an accurate result will be much more difficult to obtain by this method.

In the figure, the arrow, representing the probable future production, will cut the 10-barrel-per-month line about the end of the year 1927. Ten barrels per month in this particular field is considered as the *economic minimum,* so that we may consider that this lease will be commercially profitable until that time; and a simple arithmetic calculation is therefore all that is necessary to ascertain the probable oil reserves.

In case production data, sufficient to form the basis of a production curve, are not available, the performance of a similar well producing from the same sand should be used. This information may very probably be obtained from the *Manual,* but care should be taken that as many as possible of the surrounding conditions and circumstances are taken into consideration. Some of these circumstances will be:

1. Probability of water encroachment.
2. Possibility of use of vacuum pumps, or other artificial means of increasing the flow.
3. Effect of drilling up any undrilled locations.

Determination of Gas Reserves.—The determination of gas reserves is a difficult task and, even more than in the case of oil, is subject to the special circumstances existing in each case. The Treasury Department recommends the closed- or rock-pressure method, because of its general applicability and comparative simplicity. Under this method the decline in the closed pressure over a period is taken as indicating the reduction of the quantity of gas in the reserves.

This method is based on Boyle's Law: "At a constant temperature the volume of a given mass of gas varies inversely as the pressure sustained by it." Again, as in the case of oil, the assumption is not entirely correct owing to the migratory nature of the gas, but for practical purposes the method works out with sufficient accuracy.

The *Manual* contains various suggestions as to the best manner of obtaining reliable closed-pressure readings, such as the length of time that wells should be closed in before the gage is taken, the most satisfactory season of the year, etc.; and for this information the reader is referred to the *Manual* itself.

By far the safest method for securing an accurate estimate of either oil or gas reserves is to retain the services of a reputable firm of petroleum engineers. Care should be taken, however, that only a firm of proved experience and integrity is retained.

Division of Cost between Oil and Gas Properties.—Having determined the oil and/or gas reserves, the cost of the property applicable to the different products, if more than one, should be apportioned upon an equitable basis. It is suggested that the logical method is that of applying to the cost the ratio which the expected return from each product bears to the total expected return from all products. For example, assume the following estimated reserves and product values:

Year	Oil reserves			Gas reserves		
	Estimated production, barrels	Value at $2 per barrel, after allowing for lifting	Present value, Jan. 1, 1924, discounted at 10%	Estimated production, thousand cubic feet	Value at 10 cts. per thousand cubic feet	Present value, Jan. 1, 1924, discounted at 10%
1924	30,000	$ 60,000	$ 54,545	10,000	$1,000	$ 909
1925	20,000	40,000	33,058	8,000	800	661
1926	10,000	20,000	15,037	6,000	600	451
1927	1,000	2,000	1,370	2,000	200	137
Totals......	61,000	$122,000	$104,010	26,000	$2,600	$2,158

Further assume that this lease cost $75,000. In order to apportion this cost, then, we have:

Description	Value at Jan. 1, 1924	Per cent to total	Apportioned cost
Oil............................	$104,010	98	$73,500
Gas............................	2,158	2	1,500
Totals.........................	$106,168	100	$75,000

Depletion of Values.—As mentioned in the beginning of this chapter, depletion of values has an important place in the accounts, especially under the Federal tax laws. Since the accounting principle is the same in either the case of Mar. 1, 1913 value or discovery value, the two subjects will be treated together. These matters are, however, discussed in more detail in Part V.

When a value in excess of cost has been determined for a property and it is desired to take this excess onto the books of account, entry should be made charging the amount to an account *Appreciation of Properties* and crediting *Reserve for Appreciation of Properties.* On the balance sheet these accounts may conveniently be eliminated, thus stating the balance sheet assets at cost, less the depletion reserve.

Since the increase in the asset value of the property will have the effect of increasing the depletion unit, and hence the deduction from income for depletion sustained, this increase in depletion should be offset, as far as earned surplus is concerned, by transferring from the account *Reserve for Appreciation of Properties* to *Realized Surplus,* the proportion of the depletion charge applicable to appreciation. The theory underlying this procedure is that when the increased value of the property is brought into the accounts by means of the charge to Appreciation of Properties, the expected earnings, over and above those realized after depletion on cost is charged, are credited to unrealized surplus and suspended in the account Reserve for Appreciation of Properties until actually realized. The realization comes about, of course, through the production of the oil, etc., and is included in the earning figure of Oil Earnings.

The matter may be illustrated as follows:

Mormack Oil Company

Balance Sheet, December 31, 1923

(before providing for depletion)

Assets			*Liabilities*	
Producing Properties.........		$ 1,000,000	Capital Stock..............	$ 1,500,000
Appreciation of Properties.....	$19,000,000		Liabilities..................	25,000
Less—Reserve thereagainst	19,000,000	....	Profit and Loss Balance......	8,799,500
Equipment (less reserve)......		297,500		
Other Assets................		9,027,000		
		$10,324,500		$10,324,500

PROFIT AND LOSS STATEMENT

Oil Earnings—3,000,000 barrels at $3		$9,000,000
Miscellaneous Income		2,000
Gross Income		$9,002,000
Expenses:		
Lease Operating Expenses	$ 192,500	
General and Administrative Expense	10,000	202,500
Profit, before Depletion, carried to Balance Sheet		$8,799,500

In order to provide for depletion, the following entries are necessary:

Depletion Sustained	$6,000,000	
Depletion Reserve		$ 300,000
Appreciation of Properties		5,700,000
Being the amount of depletion sustained based on estimated reserves of 10,000,000 barrels (three-tenths of the available reserves have therefore been produced during the year).		
Reserve for Appreciation of Properties	$5,700,000	
Realized Surplus		$5,700,000
Being the proportion of the reserve for appreciation of properties, realized by production of oil (three-tenths of $19,000,000).		

The statements will now appear as shown below:

MORMACK OIL COMPANY

BALANCE SHEET, DECEMBER 31, 1923

Assets			*Liabilities*		
Producing Properties	$ 1,000,000		Capital Stock		$ 1,500,000
Less—Depletion Reserve	300,000	$ 700,000	Liabilities		25,000
			Realized Surplus:		
			At beginning of year	$........	
Appreciation of Properties	$13,300,000		Appreciation Realized	5,700,000	
Less—Reserve thereagainst	13,300,000	....		$5,700,000	
Equipment (less reserve)		297,500	Add—Profit for year	2,799,500	8,499,500
Other Assets		9,027,000			
		$10,024,500			$10,024,500

Profit and Loss Statement

Oil Earnings—3,000,000 barrels at $3		$9,000,000
Less—Depletion Sustained		6,000,000
		$3,000,000
Add—Miscellaneous Income		2,000
Gross Income		$3,002,000
Expenses:		
Lease Operating Expenses	$192,500	
General and Administrative Expense	10,000	202,500
Profit, carried to Balance Sheet		$2,799,500

Calculation and Recording of Depletion.—After the capital values have been ascertained, and the approximate oil reserves determined, the actual calculation of depletion is a simple matter. The capital value to be used for any particular year will be the book value at the end of the year; and the oil reserves figure, the estimated reserves at the beginning of the year, augmented or decreased by any production acquired or disposed of during the year. The depletion unit per barrel will be obtained by dividing the total reserves (in barrels) into the capital value.

The usual procedure is to treat each lease or pool as a separate unit, and to calculate depletion separately for each of these units. The more correct method would be to treat each *well* as a unit, but owing to operating procedure it is often impossible to obtain the necessary information for each well separately. The Treasury Department in its *Manual* recommended the calculation of a composite unit per barrel for the total of all the operator's properties, but this method would not appear to be very satisfactory.

The total amount of depletion, of course, is obtained by multiplying the unit per barrel by the total production for the year; and this figure is moreover acceptable for tax purposes. There is, however, one exception in the case of *discovery* values, which is discussed in more detail in Part V. Under the Revenue Act of 1921, depletion will not be allowed beyond the net income of the lease before charging depletion, and is limited to 50 per cent of such income under the Revenue Act of 1924, except where the capital value used is either cost, or value as at Mar. 1, 1913.

The calculation of depletion on gas properties may be arrived at in a manner somewhat different from that used for oil, by the use of the closed- or rock-pressure gages previously referred to. By this method the percentage of pressure reduction will be applied to the capital values in accordance with Boyle's Law.

A clear conception of the method of calculating depletion will be obtained from a study of the proposed *Depletion Record* (Form 10, page 93). This record has been designed to cover a period of 10 years, with a logarithmic scale on the reverse side so that the oil production, and/or gas pressure figures, may be conveniently recorded. A separate sheet of the Depletion Record should be used for each unit (pool or lease) upon which the operator is making a separate depletion calculation.

The capital value items on the form must, of course, agree with the book figures, and the intangible cost of drilling any new wells will be entered in the additions column, if the company has elected to capitalize such expenditures. The division of drilling expenses between oil and gas, where the gas (or oil) production is of commercial importance, may cause some trouble; but from past experience on the lease or in the field, it should be possible to arrive at an approximately fair division.

With regard to the estimated oil reserves, it is usual to include only the probable reserves applying to wells already drilled, and to add the estimated reserves for new wells as they are drilled. This method is equitable where the original bonus paid is insignificant as compared with the cost of development. Where the bonus is a large figure, it may be advisable to subdivide the lease into several portions for depletion purposes and to calculate depletion separately on each portion.

In the case of gas properties care should be taken that the sum of the pressures at the beginning of the year, with the new wells brought in during the year, includes the same wells as are used in arriving at the sum at the end of the year. In cases where a gas well has gone dry during the year, the pressure (zero) of the dry well or wells is likely to be overlooked. Care should also be taken that proper allowance is made, when entering the rock pressures, for atmospheric pressure and probable pressure at time of abandonment (see note at the foot of the Depletion Record).

For convenience, the depletion on cost and on appreciation in the Depletion Record have been kept separately, so that the amount to be transferred each year from Reserve for Appreciation of Properties to Realized Surplus, may be readily ascertained.

CHAPTER V

PURCHASE OF EQUIPMENT

The business of equipping an oil property is an important one, requiring a complete and practical knowledge of operating and local needs. Although there are many oil-field supply houses in the United States, The Oil Well Supply Company, The National Supply Company, The Continental Supply Company, and The Republic Supply Company sell probably three-fourths of the country's oil-well supplies. In addition to these companies, which either operate or are the selling branches of large steel companies, there exist many organizations which manufacture and distribute some special class of equipment, such as packers, tubing catchers, bits, etc.

Since many thousands of dollars must be expended in equipping a single lease, it seems hardly necessary to say that every care should be used in buying, to obtain the best prices consistent with quality; and that every precaution should be taken to insure that all equipment purchased *actually reaches the property.* The latter remark may appear a trifle far fetched, but there have been cases where equipment purchased, far in excess of reasonable requirements, developed a singular habit of disappearing at irregular intervals. In one instance in Old Mexico, several barge-loads of fittings failed to arrive at their destination, only a few miles down the river, and were never located. In another case, in Oklahoma, a contractor who erected a certain refinery on a cost-plus basis, was suspected of having made excessive purchases; later the contractor erected a refinery of his own, and it was afterwards learned that the greater part of the cost thereof was reflected in the accounts of the cost-plus refinery!

Stores Records.—The purchasing, receiving, storing, and issuing of materials and supplies should be subjected to definite accounting control. Since, with regard to these functions, the oil industry has but a few features which demand special consideration, it is necessary to outline them here in a general way only.

The detailed procedure to be followed in the installation of a complete purchasing and stores system has been discussed in numerous volumes on accounting.

Purchasing.—Where the size of the company will permit, all purchasing should be done by or through a purchasing department; though we must except from this statement such purchases as it is necessary for field superintendents and others in authority to make, on Field Emergency Orders. Regular forms of purchase requisitions, quotations required, purchase orders, etc. should be used, and care should be exercised that the system is so arranged as to coincide with the company's authorization for expenditure system (see Chap. IX). When properly carried out, the latter provides a most satisfactory internal check on purchasing; however, it is always the safer practice so to arrange the accounting routine that a copy of the purchase order is verified, by the accounting department, with the warehouse acknowledgment of receipt of the material. This procedure will have the effect of eliminating almost entirely the gravest source of fraud in connection with purchasing, namely, collusion between an employee of the purchasing department and some alleged vendor outside the organization.

Receiving Material.—The men in charge of the receipt, storing, and issuing of materials and supplies of an operating company, as is often the case with warehousemen and storekeepers, are prone to laxity with respect to making an actual count of materials received. Especially is this true where a copy of the purchase order, showing quantities to be received, is forwarded the warehouse department at the time the purchase order is made out. The natural inclination, when work is heavy and articles on the particular order are numerous, is to sign for having received the material without more than a cursory examination. In order to avoid any chance of this very objectionable habit, it is advisable that one of two courses be adopted; the first alternative is to omit the quantities from the warehouseman's copy of the purchase order, thus making it necessary for him to count or measure the material and insert this information on the order; the second, and perhaps even more effective, plan is to require a daily report of materials received to be rendered to the accounting department. In either event, the stores ledger to be kept by the warehouseman should be balanced periodically and agreed with the general ledger control.

In the accounting department a careful check must be kept upon materials ordered and received, since failure in this respect may result not only in serious financial losses from the loss of material, but may also, through the lack of necessary supplies, cause very serious delays in operations.

Storing Material.—The physical arrangement of field warehouses is a matter which should receive careful consideration. There is a case on record where the carelessness in storing heavy drilling tools and machinery on a second floor caused considerable damage, the collapse of the floor wrecking the entire building.

There is a general tendency to leave large tools, engines, boilers, and similar equipment exposed to the weather on account of the difficulty of moving them about. This practice should be prohibited, for, although it may seem certain at the time it is unloaded that the equipment will be used almost immediately, subsequent events may result in its remaining at the supply point for weeks or even months. Only recently a visit to a Texas refinery furnished a startling example of this fact; strewn over some thirty acres of ground were thousands of dollars worth of machinery and building materials intended for additions and enlargements, which construction work had been delayed owing to the depressed market for refined products. Entirely unprotected from the corrosive action of the elements, the material was deteriorating at an astonishing rate.

Warehouses used to house oil-field supplies should have bins, conveniently divided into sections; and, for the heavier parts, overhead cranes and trucks should be made a part of the regular building equipment.

The stores ledger should be kept both in quantities and values, the cost values, including freight and other expenses of transportation, being furnished by the accounting department. Probably the simplest method is to price the issues at the early costs first, so that the stock record values will always represent the latest prices. If these records are kept carefully and accurately, it will not be necessary to take a complete physical inventory at the close of the company's financial year; but the work may be so arranged that counts of the contents of every bin are made at least twice a year, and that all stocks are again counted, at their lowest point, before fresh purchases are unpacked.

As mentioned before, a trial balance of the stores ledger should be taken off and agreed with the ledger control account, at short intervals; and any differences between the physical counts made and the ledger figures should be regularly adjusted on the books.

It may be mentioned in passing that some companies lump together a large number of the smaller stores for stock ledger purposes, making the charges and issues on a weight basis. In cases where warehouses are located at a large number of different points, considerable labor may be saved in this manner.

Issuing Material.—In spite of the numerous emergencies which arise in the oil fields, there is no sound reason why every issue of materials and supplies should not be supported by a properly approved requisition. This rule should be insisted upon, and rigid adherence will soon cause the requisition to become an accepted and established institution. No special form is suggested in this respect, but provision should be made for such information as: the use to which the material is to be put; where to be used; whether renewal, replacement, repair or addition; and the like. These requisitions will form the basis for the storekeeper's periodical recapitulation to the accounting department, as well as the posting medium from which the issues side of the stores ledger will be entered.

Lease Equipment.—In the classification of accounts here presented, lease equipment embraces all equipment at wells and on leases. The various subdivisions of this account were discussed in some detail in the chapter on development. Purchases made after the lease has begun producing should be charged direct to Lease Equipment in the general ledger and posted to the subsidiary Lease Record; there is no necessity for passing these later expenditures through the Wells and Construction in Progress Record.

While it is possible to keep account of lease equipment with a reasonable degree of accuracy, prevailing operating conditions usually make impracticable any exact accounting with respect to capital assets situated in the field, especially where such assets are of a movable type. The authors know of a number of companies which have attempted to maintain a complete card record of well and lease equipment, but are not aware that any one of them has found the system altogether satisfactory. The greatest difficulty seems to arise from the unusual conditions which obtain in the oil fields. Where in many cases speed is essential to bringing, perhaps, a particular tool to the scene of operations, and where an hour's delay may cost the company thousands of dollars, one can hardly expect strict adherence to the so-called "red-tape" of accountancy.

Equipment is frequently moved from one well to another, or is transferred between leases; and the difficulty of obtaining a definite accounting control of such transfers, together with the considerable detail necessary to record field equipment, makes a complete card record of this class of equipment often impracticable. However, there is no reason why such a record cannot be kept of the larger items of lease equipment such as, derricks, casing and drive pipe, pumps, engines, boilers, and tanks. It is suggested that the card show, among other things, the following information:

Location of article,
Name and description,
Company's designating number,
Manufacturer's number,
Size, capacity, rating, etc.,
Lineal length,
Date purchased,
Purchased from,
Cost,
Applicable depreciation rate.

Space may also be provided for depreciation sustained, thus enabling the accounting department to determine the net depreciated cost of the article, when occasion arises.

If these cards are arranged by leases, it will be an easy matter, whenever operations permit, for a field man to check over the equipment on any particular lease; and if this is done regularly and systematically, all differences being carefully traced, the results obtained will be far more satisfactory than a hurried and inexact physical inventory at the end of a period.

It may be thought that the Lease Record, already discussed, will give a sufficiently accurate list of the equipment on each lease; but in actual practice it is found that a card record can be more easily handled and will contain essential information for which the Lease Record was not designed. The two records can moreover be used as a check on each other.

Other Fixed Assets.—In the case of all other tangible assets of the company the detailed card record should be maintained, arranged, first according to classes of equipment, and then according to the location of the equipment.

Where such assets are constructed by the company, a Construction in Progress sheet (Form 9, page 92) should be opened, in order that the cost of each asset erected by the company may be determined; the form will be used for *Other Uncompleted Construction* in exactly the same manner as in the case of wells in progress. Since no special conditions peculiar to the oil industry are involved, no further discussion is deemed necessary.

Some further explanation of the assets which should be included in some of the subclassifications under Other Fixed Assets may not be amiss:

Real Estate.—To this account should be charged the cost of all building and other sites owned by the company, and used in its operations. Any real estate acquired simply as a temporary investment, or for any purpose other than to be used in the operations of the business, should be charged to a special account and considered as an investment.

It is understood that no property from which the company is deriving, or is expecting to derive, oil or gas production should be included here. Unproductive freeholds, leaseholds, and royalty interests should be included in Undeveloped Properties, and later transferred to Producing Properties, as they are developed and begin to produce.

Permanent Buildings.—The charges to this account should include all expenditures made on account of the construction of buildings of a permanent character. As the accounting practice here differs in no material respect from that applicable to other industries, further discussion is unnecessary. Any buildings definitely attributable to lease activities, should of course be included under Lease Equipment.

Temporary Structures.—Although buildings originally erected with no thought of permanency may later be remodeled into structures of a permanent type, it is usually advisable to separate the capital cost of such construction work. When the building is dismantled or remodeled, the cost will then either be taken out of capital assets, or be transferred to an appropriate classification, as the case may be. Temporary structures will ordinarily include such items as bunk houses, tool sheds, field stables, garages, etc.

Drilling Equipment.—The cost of all portable rigs, drilling tools, engines, boilers, and other drilling equipment should be included under this classification. It will be noted that a special service department has been provided for in the operating accounts, in order that the cost of the company's drilling operations, especially if extensive, may be readily determined. Charge can then be made by the department at regular fixed rates per day, which can be adjusted from time to time to absorb the apparent profit or loss of the department, as shown by the books.

On account of the frequent transfer of tools, as well as the borrowing and lending thereof between operators, some difficulty may be encountered in connection with the card itemization of this class of equipment. Since this condition usually obtains only in the case of the small, and short-lived, tools the resulting discrepancies will not be relatively great, and may be adjusted periodically by means of a physical inventory.

CHAPTER VI

DEPRECIATION OF EQUIPMENT

One of the most vexatious operating factors with which industrial accounting must deal is that of depreciation. A number of methods for computing and recording depreciation have been devised, and a surprising amount has been written on the subject, as reference to the "Accountant's Index" published by the American Institute of Accountants, will confirm.

Methods of Calculating Depreciation.—There are several methods for calculating depreciation suggested by authorities on the subject, though from the practical standpoint it would appear that some of them may well be classed as neat arithmetical problems rather than as workable means for calculating depreciation. An example is furnished in the sinking-fund method, recommended by several experts, in which a sufficient fund will be accumulated for the replacement of the asset at the end of the depreciation cycle. Most operators merely desire to be assured that a sufficient deduction has been made from income to provide for wear and tear, and, as long as the amount set aside for depreciation remains in the business, it will earn its proportionate share of profits.

From an examination of the accounts of oil companies in several of the American oil fields on both sides of the Rocky Mountains and, after a study of the conditions as they exist in other localities, it seems proper that only two methods should be applied to the assets of the producing division of the oil industry, namely:

1. The straight-line method.
2. The diminishing-value method.

In the straight-line method the same percentage of the original cost of the asset is charged to operations each period; and under the diminishing-value method the percentage is applied each year to the capital values after deduction of depreciation previously provided.

There are several factors that should be considered in deciding upon the best method to adopt for any particular class of asset.

In some cases the usefulness of an asset, measured by its earning capacity, steadily decreases during its life; and in others, though the earning capacity may not materially change, the cost of upkeep in the later years may increase very considerably. Care should therefore be taken that the charges to operations for depreciation and upkeep are in approximately fair ratio to the earning capacity of the asset; and, broadly speaking, the straight-line method should be applied to long-lived and durable assets with consistent usefulness, and the diminishing-value method to those assets the usefulness of which diminishes quickly, or on which the upkeep becomes expensive in the later years.

There are two other methods which may be described as the *Units-produced* or *Depletion* method and the *Reducing-rates* method. By the units-produced method the asset is depreciated over the life of the property in proportion to the production; and by the reducing-rates method the asset is depreciated on the original value at diminishing rates for each subsequent period. These two methods, on a little reflection, will be found to be analogous to the diminishing-value method, with the basis of calculation slightly adapted to suit particular conditions.

A hypothetical case, showing the results of various methods, will perhaps make matters somewhat clearer. Suppose that a company started business in 1917 and has invested in a certain class of short-lived equipment[1] in the respective years, to the values shown below:

1917	$10,000
1918	12,500
1919	15,000
1920	12,500
1921	11,000
1922	9,000
1923	10,000
1924	12,000

Equipment of this class is subject to rough usage and deteriorates rapidly; it is therefore expected to have a useful life of only four years with a low salvage at the end of the period (about 10 per cent of the original cost).

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[1] The rates suggested will apply on an asset such as drilling equipment, and the rates shown under the reducing-rates method are those suggested in the *Manual* for this class of equipment.

Three methods of calculating depreciation present themselves (the depletion method is not applicable in this instance), the rates per annum being as follows:

	Per Cent
Straight-line method	22½
Reducing-rates method	40–25–15–10
Diminishing-value method	40

and, owing to the very heavy depreciation in the early life of the equipment, it is decided to depreciate the current additions for each year at the full year's rate.

Our example will then appear as shown on p. 46,[1] all deductions being indicated by italics.

The example brings out interesting facts as regards the relation between the three methods: First, that the diminishing-value and reducing-rates methods are practically identical; and, secondly, that after the first few initial years the charges to expense under all three methods are roughly the same where equipment is being purchased regularly, the only difference being that a less reserve is constantly maintained in the case of the straight-line method.

When considering methods, caution should be used and judgment exercised in fixing a rate under the diminishing-value method. A reasonable salvage value should be given to the asset at the end of the period (even though the asset may have little scrap value), probably at least 10 per cent, as a very low salvage value will entirely change the annual rate. An example will make this clear, where an asset costing $5,000 is depreciated over a period of 10 years to two different scrap values of $1 and $1,250. In the second case it will be necessary to employ the

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[1] The salvage in the case of the diminishing-value method is shown as 12.96 per cent for the reason that this proportion of the asset remains after charging off depreciation for four years, as follows:

	Asset before Depreciation	Depreciation at 40%	Depreciated Value
First year	100	40	60
Second year	60	24	36
Third year	36	14.4	21.6
Fourth year	21.6	8.64	12.96

Year	Particulars	Straight-line 22½ % (salvage 10 %)		Reducing-rates 40–25–15–10 % (salvage 10 %)		Diminishing-value, 40 % (salvage 12.96 %)	
		Asset	Reserve	Asset	Reserve	Asset	Reserve
1917	Equipment purchased	$10,000	....	$10,000	....	$10,000	
	Depreciation provided	....	$ 2,250	....	$ 4,000	....	$ 4,000
1918	Equipment purchased	12,500	....	12,500	....	12,500	
	Total Assets	$22,500	....	$22,500	....	$22,500	
	Depreciation provided	....	5,062	....	7,500	....	7,400
	Total Reserve	....	$ 7,312	....	$11,500	....	$11,400
1919	Equipment purchased	15,000	....	15,000	....	15,000	
	Total Assets	$37,500	....	$37,500	....	$37,500	
	Depreciation provided	....	8,438	....	10,625	....	10,440
	Total Reserve	....	$15,750	....	$22,125	....	$21,840
1920	Equipment purchased	12,500	....	12,500	....	12,500	
	Total Assets	$50,000	....	$50,000	....	$50,000	
	Depreciation provided	....	11,250	....	11,625	....	11,264
	Salvage (1917)	*1,000*	....	*1,000*	....	*1,296*	
	Depreciated assets set off against reserve	*9,000*	*9,000*	*9,000*	*9,000*	*8,704*	*8,704*
	Totals	$40,000	$18,000	$40,000	$24,750	$40,000	$24,400
1921	Equipment purchased	11,000	....	11,000	....	11,000	
	Total Assets	$51,000	....	$51,000	....	$51,000	
	Depreciation provided	....	11,475	....	11,025	....	10,640
	Salvage (1918)	*1,250*	....	*1,250*	....	*1,620*	
	Depreciated assets set off against reserve	*11,250*	*11,250*	*11,250*	*11,250*	*10,880*	*10,880*
	Totals	$38,500	$18,225	$38,500	$24,525	$38,500	$24,160
1922	Equipment purchased	9,000	....	9,000	....	9,000	
	Total Assets	$47,500	....	$47,500	....	$47,500	
	Depreciation provided	....	10,687	....	9,725	....	9,336
	Salvage (1919)	*1,500*	....	*1,500*	....	*1,944*	
	Depreciated assets set off against reserve	*13,500*	*13,500*	*13,500*	*13,500*	*13,056*	*13,056*
	Totals	$32,500	$15,412	$32,500	$20,750	$32,500	$20,440
1923	Equipment purchased	10,000	....	10,000	....	10,000	
	Total Assets	$42,500	....	$42,500	....	$42,500	
	Depreciation provided	....	9,563	....	9,150	....	8,824
	Salvage (1920)	*1,250*	....	*1,250*	....	*1,620*	
	Depreciated assets set off against reserve	*11,250*	*11,250*	*11,250*	*11,250*	*10,880*	*10,880*
	Totals	$30,000	$13,725	$30,000	$18,650	$30,000	$18,384
1924	Equipment purchased	12,000	....	12,000	....	12,000	
	Total Assets	$42,000	....	$42,000	....	$42,000	
	Depreciation provided	....	9,450	....	9,750	....	9,446
	Salvage (1921)	*1,100*	....	*1,100*	....	*1,426*	
	Depreciated assets set off against reserve	*9,900*	*9,900*	*9,900*	*9,900*	*9,574*	*9,574*
	Totals	$31,000	$13,275	$31,000	$18,500	$31,000	$18,256

not excessive rate of 12.95 per cent, whereas in the first case an increase of the rate to 57.33 per cent is necessary:

Case 1	Asset before depreciation	Depreciation at 57.33%	Depreciated value
First year	$5,000.00	$2,866.75	$2,133.25
Second year	2,133.25	1,223.05	910.20
Third year	910.20	521.84	388.36
Fourth year	388.36	222.66	165.70
Fifth year	165.70	95.00	70.70
Sixth year	70.70	40.53	30.17
Seventh year	30.17	17.30	12.87
Eighth year	12.87	7.38	5.49
Ninth year	5.49	3.25	2.24
Tenth year	2.24	1.24	1.00
		$4,999.00	

Case 2	Asset before depreciation	Depreciation at 12.95%	Depreciated value
First year	$5,000.00	$ 647.50	$4,352.50
Second year	4,352.50	563.65	3,788.85
Third year	3,788.85	490.40	3,298.45
Fourth year	3,298.45	426.90	2,871.55
Fifth year	2,871.55	371.70	2,499.85
Sixth year	2,499.85	323.60	2,176.25
Seventh year	2,176.25	281.60	1,894.65
Eighth year	1,894.65	245.20	1,649.45
Ninth year	1,649.45	213.30	1,436.15
Tenth year	1,436.15	185.80	1,250.35
		$3,749.65	

It will be seen in the first case that the greater part of the depreciation is taken up in the first two years, and that in the second case it is more equitably distributed over the period. It is hardly necessary to point out that from a practical standpoint the second example is likely to be closer to the facts as they exist.

There is one other point that might be mentioned in favor of either the straight-line or the diminishing-value method, and that is the relative time consumed in the actual computations. The diminishing-value method will probably entail slightly more time than the straight-line method; but, when it is considered that each year's additions must be taken separately in calculations under the reducing-rates method, it will readily be seen that this method, where the calculations are numerous, will consume considerably more time than the others.

The assets of a producing company may be divided into three main classes, depending upon how closely they are associated with producing operations, namely:

General lease equipment.
Well equipment.
Other fixed assets.

This division is a simple and natural one, and has been adhered to in the card of accounts, except that in actual practice it is difficult to distinguish entirely between equipment definitely associated with a well, and equipment of a more general nature on the lease. In fields where separate power units are used for each well, these units should be included as well equipment; but where pumping is done from a central power station, well equipment should include only permanent derricks at the wells, together with all casing, tubing, sucker rods and similar equipment.

General Lease Equipment.—It must be understood that the restriction implied by the caption *Lease Equipment* does not exist; in other words equipment on either a freehold or a leasehold is called lease equipment, regardless of the kind of interest which the company owns in the property. The term has the prerogative of usage, and as a matter of fact no better one suggests itself, unless it be Oil and Gas Properties Equipment. The latter phrase becomes cumbersome, however, when coupled with another word or so, as in the case of Uncompleted Oil and Gas Properties Equipment.

By referring to the production card of accounts (page 82), the reader will find that lease equipment has been divided into six subaccounts. Although it is possible to divide the equipment of a lease and its wells into thirty or forty subaccounts, this procedure would seem unnecessary, as the information furnished by such a minute division is of little value to anyone, and certainly multiplies the accounting work several times. During the years of high taxes, however, the Department of Internal Revenue often demanded very exhaustive information concerning equipment, so that more detailed records were then necessary.

General lease equipment, other than well equipment, is usually depreciated on the straight-line method taking into account the quality, size, and age of the units, and their probable useful life in their present positions, based on estimated oil reserves, etc. The rates suggested in the *Manual*, quoted at the end of this chapter, will be of use in this connection.

Depreciation is usually calculated on the total of all equipment of a certain class, the reserve representing an average provision for the whole class. If, therefore, an asset is scrapped earlier or later than the average life indicated by the depreciation rate, the resultant over- or underprovision on that particular asset should be adjusted to the reserve account and not to operating expenses. The most satisfactory method, when an item is sold or scrapped, is to credit the salvage to the asset account and charge the reserve account (crediting the asset) with the difference between the salvage and the original cost. A common practice is to credit the asset account with the estimated depreciated value of the unit of equipment removed, and to make no adjustment to the reserve account. It will be realized that, as far as the statement of the net asset is concerned, this method will give a correct result, provided that the depreciated value has been estimated with a reasonable degree of accuracy. However, when straight-line depreciation computations are made upon the gross assets as reflected by the ledger account, the difference between the actual cost and the estimated value at which any items of equipment had been removed from the asset account, would be depreciated upon indefinitely; these differences should therefore be ascertained as accurately as possible, and the necessary entries put through the books.

Well Equipment.—For the purpose of discussion in connection with depreciation, well equipment is here considered separately from general lease equipment. However, it should be borne in mind that these two classes of equipment are embraced by the term Lease Equipment in the card of accounts, and that no practical purpose is ordinarily served by making any distinction between them.

Since practically the whole of the value of the well equipment will be gone when the property is exhausted, the method suggested for depreciating such equipment is the units-produced method.

Under this plan, the depreciated cost of the assets is divided by the estimated remaining oil or gas reserves, and the resultant *unit of depreciation* is applied to the production for each period, in order to determine the depreciation for that period. The principle here involved is exactly the same as in the case of depletion.

It will be observed that the diminished value of the asset is used in this computation, rather than total cost. When it is considered, however, that a new oil reserve figure is used for each year, it will readily be seen that this method is comparable in effect to the reducing-rates method previously described, taking the usefulness of the equipment (that is, its productiveness) as the basis.

Under the units-produced method, repairs, renewals, and replacements should usually be charged off to current maintenance expense. In the case of an extraordinary and expensive maintenance expenditure, however, occasioned by storm or other accident, there is no objection to apportioning the amount over several months' operations, instead of charging it off at once against the operations of a single month.

The impression should not be received that there is any attempt herein to depart from sound accounting principles in the matter of depreciation under the units-produced method. The method is founded on expediency and conditions as they exist. For example, in the case of a well where the derrick has been left standing for pumping and cleaning-out purposes, the investment in the derrick alone, will be from $500 to $2,000. The derrick has practically no salvage value, as the cost of dismantling and moving it would usually more than offset any amount which might be obtained for it. Repairs and renewals are small in amount in connection with such a derrick, except in the event of a windstorm, fire, or other accident. In this case the derrick must be rebuilt or replaced, but the life of the asset remains unaffected, since it is entirely dependent upon the life of the oil property.

Although casing is seldom, if ever, replaced, it frequently happens that some of the casing can be pulled from the well upon abandonment. The salvage value of such casing, however, is seldom of any moment, on account of its corroded condition and the fact that it is usually pulled out of shape in removing it from the hole. The combination of these two factors makes it altogether improbable that any attempt to use such casing in another well will be made, since the collapse of the casing would probably mean a ruined well.

There are conditions of course, under which the life of a property may be considerably longer than that of the equipment thereon. For example, there are wells in the Pennsylvania and West Virginia fields which have been pumping a small amount of oil for 20 or 30 years. In these circumstances the best plan would seem to be to divide the life of the property into periods corresponding with the life of the equipment thereon, calculating a new depreciation unit for each period.

Other Fixed Assets.—Assets, other than those which may be classified as lease or well equipment, have been divided into the following subaccounts in the card of accounts for the production division of the industry:

Real estate.
Permanent buildings.
Temporary structures.
Drilling equipment.
Machine-shop equipment.
Miscellaneous tools and equipment.
Water wells.
Water and gas lines.
Engineering and laboratory equipment.
Telephone and telegraph facilities.
Automobiles and trucks.
Live stock and vehicles.
Furniture and fixtures.

It will be noted that provision has not been made for storage tanks, which are more in the nature of storage equipment, and will be treated of in Part II.

As explained in Chap. V, a card record of all capital assets other than lease equipment, should be kept. Depreciation is to be computed by the straight-line method at similar rates to those suggested at the end of this chapter. It is to be understood, of course, that these rates may be altered when circumstances show that they are not applicable in a particular case, or when the experience in the field in which the company is operating demands the use of different rates. As the rates are to be applied to the gross value of the asset, and not to the diminished value, care must be taken that fully depreciated assets are removed from the asset account and charged against the reserve. Assets disposed of or scrapped before the expiration of their estimated life, must be adjusted by charging any difference between the salvage and the original cost against the depreciation reserve. As elsewhere explained in this chapter, the selection of a composite, or average, rate anticipates that certain of the assets will be scrapped before the average term of years, while others will exceed such expectation. The overreserve on the longer-lived assets may therefore be considered as applying on those of shorter life.

After a company has been operating for a number of years and assuming that, on an average, the assets, being of all ages from new to worn out, are actually 50 per cent depreciated, the depreciation reserve should be approximately 50 per cent of the asset account, and the provision should be so adjusted from time to time as to keep it there.

Real Estate.—Ordinarily, real estate used for buildings or other sites will not depreciate, at least in a well-defined manner. If it becomes necessary to depreciate real estate, however, rates will need to be established to record the facts as they are determined to exist. No rule for this establishment of rates is practicable, but the fact should not be overlooked that appreciation in market value often more than offsets any shrinkage in operating value which may be experienced.

Permanent Buildings.—In the card record there will be no difficulty in separating buildings into classes, according to the material from which they are constructed. The following four classifications will cover the average experience:

Small wood buildings.
Frame buildings on brick or concrete foundation.
Corrugated iron siding.
Concrete, brick or steel frame.

Temporary Structures.—Depreciation sustained in the case of temporary structures will be represented by the difference between the cost of erection and the salvage value. It is usually the better practice to wait until the building is dismantled, before attempting to determine the amount of depreciation which has taken place. However, where the amount is substantial, it may be advisable to anticipate the amount applicable to the operations of a period, in order that a large undepreciated asset will not be carried over into a subsequent period.

Having computed the depreciation for a period, charge should be made to the various expense accounts involved, with credit to depreciation reserve. Depreciation of drilling equipment will be charged to the service division Drilling Department, which latter account will be cleared each month to the wells benefited. In like manner, depreciation attributable to the other service departments will be charged thereto, and cleared out with the other expenses. Depreciation of lease equipment should be charged to the account Depreciation, under expenses, as should that on machine-shop equipment, miscellaneous tools, water wells, water and gas lines, etc. It may become necessary to divide depreciation on some classes of equipment arbitrarily, in order to apportion it to the leases. This can be done by using the ratio of the pumping labor and expense of each lease, to the total pumping labor and expense of all leases.

Depreciation Rates Recommended by Manual for the Oil and Gas Industry.—The depreciation rates set out in the *Manual* are used by a number of operators, but it should be pointed out that these rates, in the words of the *Manual:*

> . . . are intended as a suggestion. . . . The percentages are neither maximum nor minimum rates. They are not to be applied indiscriminately to specific property, and the Internal Revenue Bureau is in no way committed to accept allowances based upon them.

The *suggested* rates are as follows:

Class of Equipment	Including	Suggested Annual Rate, Per Cent
1. Drilling equipment	Engines, boilers, rig irons, and portable derricks	40–25–15–10 (Salvage 10)
2. Well equipment	Wells and their equipment	As depletion
3. Dehydrators	Electric	20
	Pipe or tank type	50
4. Tanks	Steel—2,500 to 5,000 barrels	8⅓
	Steel—5,000 to 55,000 barrels	5
	Galvanized iron—Up to 500 barrels	12½
	Galvanized iron—500 to 2,500 barrels	8⅓
	Wood	20
	Movable, galvanized iron—Up to 500 barrels	16⅔
	Movable, galvanized iron—500 to 2,500 barrels	11⅑
	Water, galvanized iron movable—Up to 500 barrels	20
	Water, galvanized iron movable—500 to 2,500 barrels	12½
5. Tools	Standard, rotary, and fishing	33⅓
6. Transportation equipment.	Motor trucks, autos, wagons, horses, and harness	33⅓
7. Water plants	Water well, pump, steam power, gas and oil power, electric power	10
8. Electric equipment	Generators, motors, transformers, wiring (inside and outside), power lines, and switchboard	10
9. Machine-shop	Wood buildings, power tools, blacksmith tools, small hand tools, shafting, and shop power	14 2/7
10. Buildings	Wood	10
	Frame on brick or concrete foundation	6⅔
	Corrugated iron siding	16⅔
	Concrete, brick, and steel frame	4

CHAPTER VII

PRODUCTION EXPENSES

The production or *lifting* expenses of an oil company may be broadly classified under four main captions, as follows:

- Pumping labor and expense.
- Depreciation.
- Maintenance expense, subdivided into:
  - Labor.
  - Repair parts and expense.
  - Cleaning out.
- General lease expense.

While there may be merit in a moderate itemization of production expenses, there seems little to be gained by the exhaustive analyses which are only too frequently found in oil-production accounts. With this fact in mind, an effort has been made to be as concise as possible in dividing the accounts here presented.

Lifting Cost Discussed.—Some little difference of opinion exists among oil accountants as to just which expenses should be considered as lifting cost. It is advisable, therefore, briefly to state what appears to be the best practice in this connection. As the first two items of expense, we have pumping labor and expense, and depreciation sustained with respect to the equipment, the latter being set out in a separate account only for the sake of accounting convenience.

Pumping labor and expense will include such expenses as the following, and will constitute the major portion of the lifting expenses:

Pumpers' labor,
Power used,
Steam,
Water,
Fuel,
Oil and waste.

Depreciation, to which a chapter has been devoted in this volume, should also be considered as a part of the production costs, and will include all depreciation of lease and well equipment.

Maintenance expense, conveniently subdivided, comprises the third item of production cost, and should include all outlays for repairs, renewals, or replacements in respect of lease equipment.

General lease expense may be further subdivided, in the company's discretion, and should include such items as superintendence, miscellaneous costs of moving lines, cleaning tanks, a proportion of such service accounts as Garage and Stable Department, etc.

The principle of cost accounting which has established in manufacturing industries the axiom that *cost stops at the factory door,* is also applicable in the case of production costs of oil-producing companies; cost, then, ceases at the edge of the lease and the expenses of the accounting and administrative divisions should not be included in production costs.

Division of Production Expenses among Wells.—It is quite possible to record all production expenses by wells, with the exception of those described as general lease expenses which can later be allocated to wells upon some selected basis, as for example pumping hours. However, in actual practice, the information furnished by thus dividing expenses is of but little value, since in only a few fields, such as some of the Pennsylvania and California fields, is any attempt made to keep production revenue separate by wells. In ordinary practice the production from several wells is run into one series of tanks, making it impossible to obtain a record of the oil produced from each well individually.

As a matter of fact there seem very good reasons to support a contention that any operating results which show different lifting costs for various wells on the same lease, must be erroneous. For, after all, the purpose of operating a well, or a group of wells on a lease, is not to produce just what oil may drain into particular holes, but rather to produce from the whole lease as many barrels of oil as are commercially extractable. The fact that one well may be unfavorably situated and for that reason may require more pumping, or heavier repairs, does not signify that its particular production is costing more; the lease must be considered as a whole, and the total reserves taken as the objective.

In view of the facts stated, it would seem that production expense may be defined as the *cost of operating and maintaining* *a producing lease,* and that the cost of producing a barrel of oil can be found only by dividing the total operating and maintenance expenditure for the lease by the total barrels produced during the same period. Any attempt to find such costs by wells must employ, to some extent, arbitrary methods of allocation.

Service Departments Income and Expense.—Most oil companies operate, in some form or other, what may be termed *service departments.* By service departments are meant those divisions of operation which are maintained for the benefit of the general producing division. In addition to the four for which provision has been made in the present classification of accounts, several others, as for example boiler plant, electric plant, and water wells, may exist. The principle of grouping into one account the costs of rendering the service in question, and of apportioning a ratable share to the benefiting units, will be the same in each case.

Drilling Department costs of operation of a company should be kept separately in order that the relative merits of operating its own drilling equipment, as compared with the alternative of letting out its drilling work to drilling contractors, may be determined and compared. When some further subdivision of this class of expense is desired, the drilling expense sheet in the general ledger may be arranged in columnar form, providing for such a division as follows:

Labor of drillers, tool dressers, etc.
Steam, water, and fuel.
Other supplies and expense.
General superintendence.
Repairs.

On the basis of a drilling department report, the total expenses for a period should be cleared out to Wells in Progress, such expenses as are not directly chargeable to any particular job being spread upon some equitable basis, as for example, Drilling Days Worked. Where the operations of this department are extensive, it may become necessary to open a regular job-order system of cost accounting, along identically the same general lines as those in use by building contractors. Any of the usual textbooks on cost accounting may be referred to in installing such a system.[1]

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[1] As, for example NICHOLSON and ROHRBACH, "Cost Accounting," or JORDAN and HARRIS, "Cost Accounting Principles and Practice."

Any revenue derived from rendering service to outside interests, or from such miscellaneous sources as tool rentals, etc., should be considered as a credit against the department's expenses for the period, unless such revenue becomes relatively large. In the latter event it may be stated separately in the Profit and Loss account.

Warehouse Department.—If strict accounting principle is adhered to, at least a portion of the warehouse expenses should be considered as forming a part of the cost of the material stored. The simpler and more expedient method, however, is that of charging against income all warehouse department expenses for the period. In this manner no questionable *oncosts* are capitalized, warehouse stock records are considerably simplified, and the general accounting records are relieved of no mean amount of additional detail.

Should the company prefer to add the warehouse expenses to material costs, however, it is suggested that some fixed percentage be applied to the cost of stores received and warehouse expense credited. Such a percentage will of necessity be somewhat arbitrary, and may best be determined by dividing the average monthly warehouse expense by a similar monthly average of stores issues.

Just as was explained for the drilling department, a further subdivision of warehouse department expense may be accomplished by arranging for columns on the general ledger expense sheet, these columns according with whatever classification is deemed necessary.

Engineering and Geological Department.—The greater part of the work done by this department will be in the nature of preparation for development of properties, together with the direction of the actual work. The account should include such expenses as the following:

Salaries of scouts, geologists, petroleum engineers, and others,
Traveling expense,
Office supplies,
Other supplies and expense.

Clearance should be made to properties benefiting, on the basis of a monthly report summarizing the department's activities. In the company's discretion, and depending upon the circumstances, some of this expense may be cleared to a special classification under administrative expense, especially where lease-buying falls within the province of the engineering and geological department.

Garage and Stable Department.—In most oil company operations, especially in the cases of the larger companies, trucking and teaming constitute two of the biggest items of development and operating expense. In order that accurate accounting may be had of this class of expense, the better practice is to treat all such work as emanating from a service department.

It will be noted that the Payroll Record (Form 7, page 90), has been designed with a view to including also teaming roll. In many instances man, team, and wagon are hired at a fixed rate per diem, just as in the case of ordinary workmen. On the basis of daily time reports, the garage and stable department expense arising from trucking and teaming payrolls can be cleared to units served.

Such department expenses as cannot be directly allocated to any particular unit, should be considered as burden and spread upon some arbitrary basis. The *labor-hour* method is suggested as the most suitable means for making this distribution, although a great many companies use the *labor-amount* method. Under the former, the total undistributed burden is divided by the total labor hours worked during the period. The resultant quotient is multiplied by the number of hours worked on each operating unit, thus obtaining the apportionable burden for that particular unit. Under the latter method the same procedure is followed, with the exception that amounts are used, rather than hours, as a basis for the distribution.

Commissary Accounts.—One of the serious labor problems confronting oil companies, especially those operating in foreign or remote American fields, is that of furnishing workmen with ordinary living supplies. In order to meet this situation, many companies are obliged to maintain commissary stores, from which points of supply articles of food, clothing, etc. are dispensed to the men at approximate cost.

Commissary accounting might be discussed in considerable detail, but it is believed that a general indication of methods and principles will serve a better purpose than any attempt to outline a specific accounting system.

As in the case of warehouse materials, all supplies at commissary stores must be made subject to definite accounting control. Since, in most cases, a percentage will be added to cost prices in order to fix selling prices (assuming that the company is endeavoring to break even rather than to derive a profit from such operations), but little difficulty will be encountered in costing each sale in a sales register. This register may then become the basis for all other records kept, including a stock ledger.

It will be found that a large number of the sales will be made on *Deduction Tickets*, which later will be remitted to the general offices in lieu of cash. These tickets, summarized for each employee, will be deducted from pay checks.

The imprest-cash-fund system should be used by commissary stores, and the periodic reports should receive careful audit in the accounting department. Where coupons are sold to employees in advance, every precaution should be taken that careful account thereof is kept, with special attention to an automatic check by serial number. For all purposes these coupons should be treated as cash, both for practical and psychological reasons; it is a remarkable fact that many large companies, with well-developed systems of internal check, are very lax in this respect and have suffered considerable cash losses in consequence.

CHAPTER VIII

PRODUCTION EARNINGS

Crude petroleum, the black gold of our modern fiction writers, has come to occupy a prominent place among the world's most important products. So ready is the market for it, that the practice of considering oil production as an earning, whether sold or not, has become well established. The highest price at which crude oil has ever sold was $20 per barrel. This figure was received from September of 1859 until sometime during January of 1860. However, America's petroleum industry may be said to have been built upon oil selling at from 50 cents to $2 per barrel, the prices varying with the demand and between the different fields. Just after the beginning of the World War, when America's exports began to increase by leaps and bounds, crude oil started advancing, and from about 50 cents per barrel in 1915 had reached $3.50 and $4 per barrel by the middle of 1920.

In order that those who are interested in the economic as well as the operating aspects of the industry may gain some idea of the relative fluctuations of the crude-oil market as compared with the market for such other staples as cotton, pig iron, and farm products, Fig. 3 has been prepared. In the upper curves, comparison is made for the years from 1920 to 1924, the prices prevailing during 1913 being taken as representing 100 per cent. In the lower curve, the average prices of all commodities since 1890 have been plotted, comparison being made with crude-oil prices from 1913 to 1923. The consistently sharp upward trend of oil, exceeding considerably that of average commodities, from 1915 to 1920 is attributable in a large measure to the special demands made on the industry by the war, while the equally sharp downward slant from 1920 to 1923 arises from a combination of post-war market decline, and the discovery of new fields in Oklahoma and California.

The income of an oil-producing company may be classified as to sources, somewhat as follows:

Oil earnings.

Gas earnings, including casinghead gas.

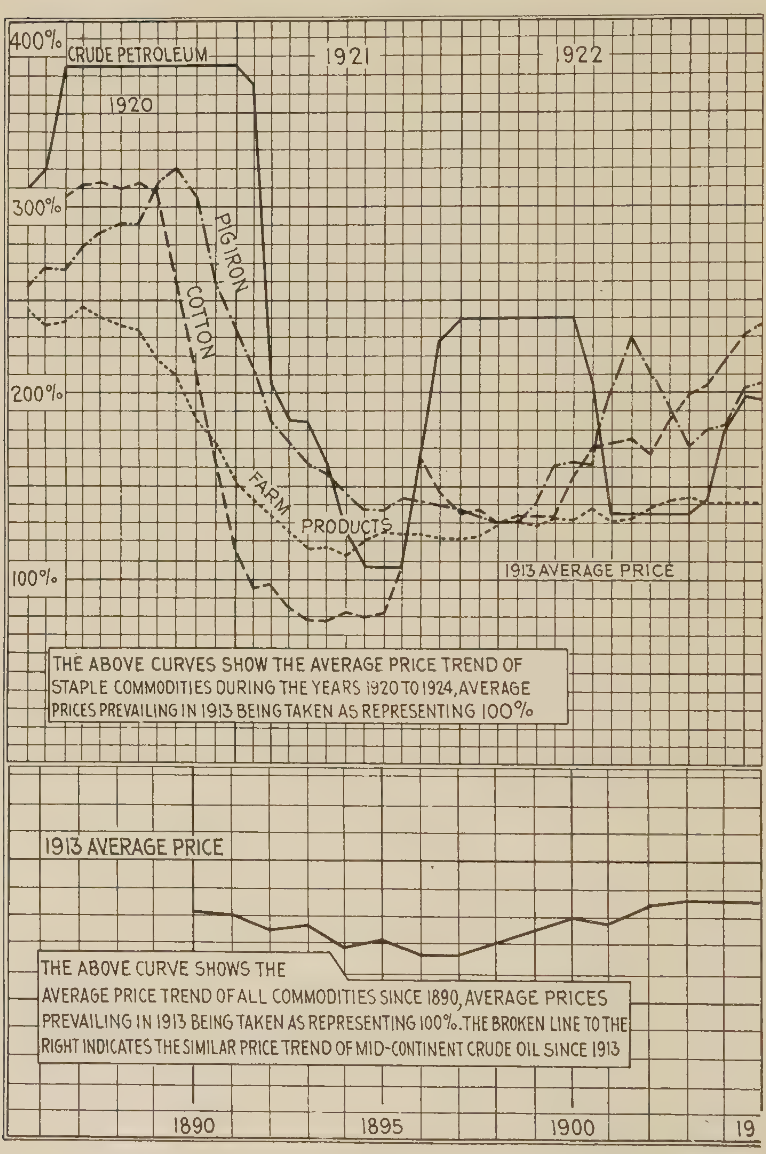
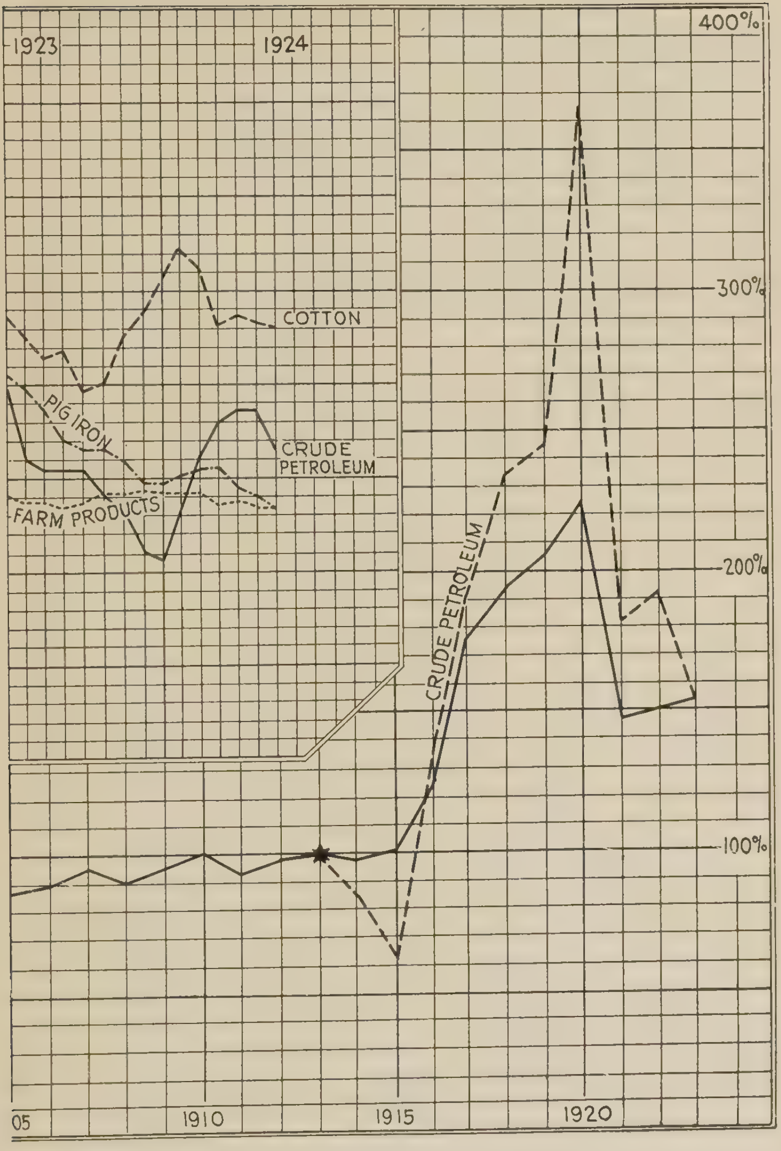


Fig. 3.—Comparative



price fluctuations.

Other lease earnings, including water sales, crop, etc. revenue, steam sales, electricity sales, and commissary net income.
Royalties received.
Rent earnings from tools, buildings, etc.
Investment income, affiliated companies.
Investment income, other.
Interest on Government securities.
Miscellaneous income.

The revenue arising from the sale of oil will be the principal income, in the case of the average company, although there are some few companies engaged solely in the business of producing and distributing dry gas.

Oil Earnings.—The subject of production earnings has received but scant attention from writers upon phases of petroleum accounting. The general inclination seems to have been to assume that oil sold represents the earning account, and to disregard inventories by the simple process of failing to mention them.

In connection with the perusal of the present chapter, the reader should refer to the *Production Record* (Form 8, page 91), as well as to the *Run Ticket* (Fig. 4). It will be observed that the information for which space has been provided in the first of these two forms, furnishes a complete accounting for all production from the company's holdings; however, only by care in balancing all figures is it possible to operate this system accurately. Where a lease is provided with several tanks, it will be necessary to use a sheet for each tank.

Recording Production of Oil.—As has been explained, the basis for all production records is furnished by the run ticket (Fig. 4). As oil is produced from the flowing or pumping well, it is conducted into run tanks.[1] In order that the quantity of oil produced may be ascertained, a periodic gage is made of the contents of the receiving tank.[2] The previous gage, converted into equivalent barrels by means of a tank table[3] and subtracted from the present gage, similarly converted, will indicate the quantity of oil produced during the period. These gages are recorded on the run ticket (which should be of convenient size for use in the field) by the employee making the gage, and the tickets are forwarded to the accounting department. Here they are posted to the production record sheets for the various tanks.

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[1] The subjects of dehydration, and other treatment are discussed in Part II.

[2] It may be mentioned that, although a number of devices for metering oil have been patented, none of them seems to have proved satisfactory.

[3] *Tank tables* are made up, one for each individual tank, by a man who makes a profession of *strapping* tanks, that is, of measuring tanks and compiling tables of the equivalent in barrels to various measurements,

Practically all crude petroleum contains emulsified and free water, as well as sediment and other undesirable matter, in a greater or lesser degree. Upon standing for a few hours, these foreign elements may settle to the bottom of the containing tanks, and can be drawn off at intervals. In order to have proper record of such withdrawals from the tank contents, it becomes necessary to make a gage, in the same manner as in the case of production. This gage is entered upon a run ticket, which is properly designated and forwarded to the accounting department for posting to the production record.

The net production for a period, of course, will be represented by the difference between gaged production and basic sediment and water drawn off, as brought out in the summary of barrels on the reverse side of the production record.

Many companies use different forms for Gage Tickets (production) and Run Tickets (deliveries) but, as the information to be shown in each is practically identical, only one form is presented here. It will be noted, however, that in the case of production no entries will be made for temperature and other corrections, for the reason that these corrections are not considered necessary except when the oil is actually sold.

Recording Oil Deliveries.—Just as is done with production, the receiving tanks are gaged before and after delivery of a tank of oil to the pipe-line purchasing or transporting company. The run tickets are forwarded to the accounting department as before.

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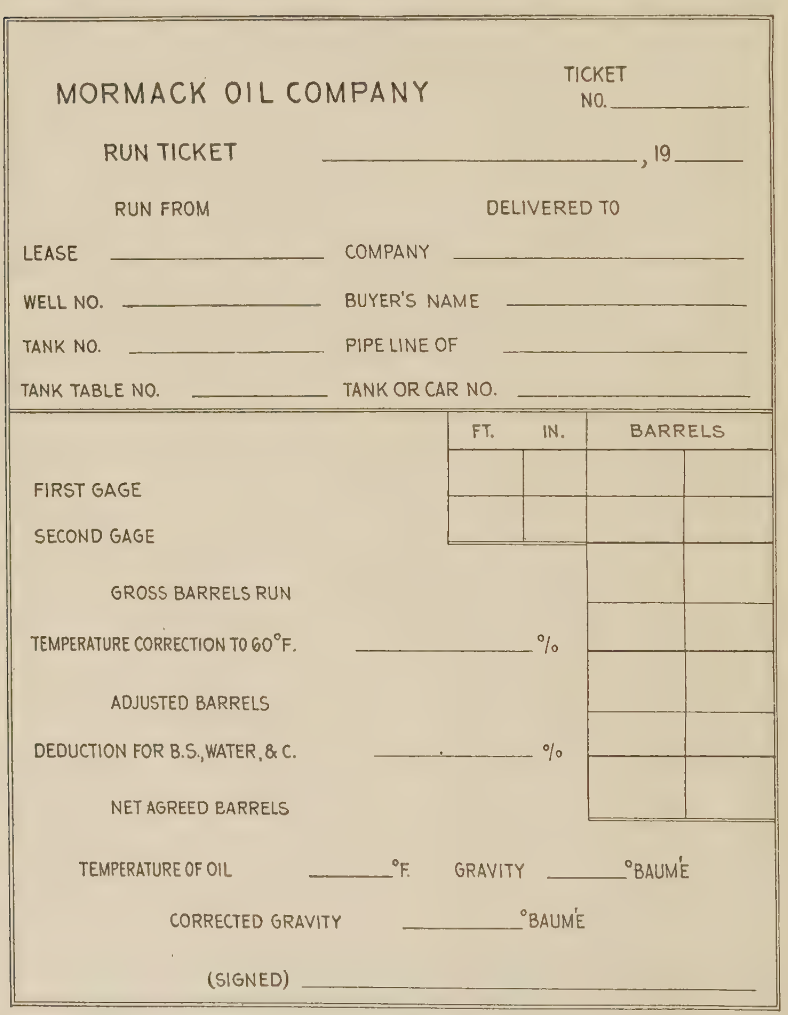
graduated to fractions of an inch. Lately there have been published in California two volumes on the subject of tank strapping, but it is unlikely that they will have the effect of causing many companies to compile their own tables, since the position of the strapper is somewhat analogous to that of the professional accountant; he is an independent and disinterested party.

It is of interest to note that in some fields the volume shown by the tank table is not the actual volumetric content of the tank. A small percentage allowance may be made for basic sediment and water and, as long as the actual impurities in the oil do not exceed this percentage, the oil is accepted by the pipe-line companies at the tank-table volume.

It has been explained that oil is bought and sold on the basis of 60°F. (see Chap. I). Varying according to types of crude oil, and treating practice of producers, pipe-line purchasing companies deduct a percentage of quantities (called a *pipe-line allowance*), in order to care for basic sediment and water. These adjustments, for temperature and for foreign matter, must be taken into consideration in the records in order that all production may be accounted for. The run ticket and production record



MORMACK OIL COMPANY

TICKET NO. ____________

RUN TICKET

____________________, 19____

RUN FROM

DELIVERED TO

LEASE ____________

COMPANY ____________

WELL NO. ____________

BUYER'S NAME ____________

TANK NO. ____________

PIPE LINE OF ____________

TANK TABLE NO. ____________

TANK OR CAR NO. ____________

	FT.	IN.	BARRELS	
FIRST GAGE				
SECOND GAGE				
GROSS BARRELS RUN				
TEMPERATURE CORRECTION TO 60°F. ____________ %				
ADJUSTED BARRELS				
DEDUCTION FOR B.S., WATER, & C. ____________ %				
NET AGREED BARRELS				

TEMPERATURE OF OIL ________ °F. GRAVITY ________ °BAUMÉ

CORRECTED GRAVITY ________ °BAUMÉ

(SIGNED) ____________________

FIG. 4.—Form of run ticket. (4¼ × 5½ in.)

have been so arranged as to reflect all of this information, and the reader will be well advised to devote some time to studying them in order to understand thoroughly the mechanics of their operation.

Current textbooks have been searched in vain for convenient and concise tables which may be used by the field men of small operators in adjusting, for temperature, the barrelages and gravities of oil in field tanks. The larger companies prepare such tables themselves for use in their organizations, but for the smaller concerns the following two tables, carefully prepared from the circular stated in the footnote, may be of use. In small tanks, of course, the volume adjustment will not be very great, but a difference of .1 or .2° in the Baumé gravity in many fields, may change the price per barrel of the oil.

Production Record (Form 8, page 91).—The reverse side of the production record will summarize for the period all production operations of the lease; a master lease sheet should be used where several tanks are situated on the same lease.

From the viewpoint of accounting for physical production, the company must record carefully all quantities, both its own and those belonging to other interests. The *Summary of Barrels* portion on the reverse side of the production record sheet may be briefly explained as follows:

> To the total quantity of oil on hand at the beginning of the period, add the net production during the period.
>
> From the total thus obtained, deduct the net deliveries during the period.
>
> The resultant figure would equal stocks on hand at the close of the period were it not for the fact that certain temperature and sediment adjustments were made by the buyer.
>
> In order then to account for this difference between theoretical and actual stocks on hand, we add back whatever deductions the buyer has made, and conversely deduct any additions.
>
> By this means a reconciliation of theoretical with actual stocks is accomplished.

In actual practice the production accruing to other interests may either be delivered directly to the pipe-line company, in which event the buyer assumes the obligation of settling with the other interested parties on the basis of the division order, or it may be delivered, partially or wholly, to the other party direct. Where this latter procedure is followed, it usually occurs only with other working interests, rarely with royalty interests. The practice introduces a slight complication, in

Table Showing Percentage Necessary to Add to or Deduct from Gaged Volumes at Varying Temperatures, in Order to Correct to 60°F.[1]

Degrees Fahrenheit	Observed degrees Baumé												
	16	18	20	22	24	26	28	30	32	34	36	38	40
30	.....	1.1 %	1.2 %	1.2 %	1.2 %	1.2 %	1.3 %	1.3 %	1.3 %	1.4 %	1.4 %	1.4 %	1.5 %
35	.....	.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.2
40	.....	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9
45	.....	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.7
50	.....	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5	.5
55	.....	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
60				Add—above this line									
60				Deduct—below this line									
65	.....	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
70	.....	.4	.4	.4	.4	.4	.4	.4	.4	.4	.5	.5	.5
75	.....	.6	.6	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7
80	.....	.8	.8	.8	.8	.8	.8	.8	.9	.9	.9	.9	1.0
85	.....	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.2
90	.....	1.2	1.2	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3	1.4	1.4
95	.....	1.3	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.6
100	.....	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.7	1.8	1.8	1.8	1.9
105	.....	1.7	1.8	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.0	2.0	2.1
110	.....	1.9	1.9	2.0	2.0	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3
115	.....	2.1	2.1	2.2	2.2	2.2	2.2	2.3	2.3	2.4	2.4	2.5	2.5
120	.....	2.3	2.3	2.4	2.4	2.4	2.4	2.5	2.5	2.6	2.6	2.7	2.7

Example.—What is the corrected volume of 540 gaged barrels of oil with an observed gravity of 30.4°Bé. at 80°F? Follow the 80°F. line along until you come to the 30°Bé. column (the nearest shown to 30.4) and note a deduction of .8 per cent. Actual volume at 60°F. will be 99.2 per cent of 540 barrels or 535.7 barrels.

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[1] The figures above, with slight interpolations, were calculated from tables in *Circ.* 57, U. S. Standard Tables for Petroleum Oils, Bureau of Standards, U. S. Department of Commerce.

Table Showing Amount Necessary to Add to or Deduct from Observed Degrees Baumé at Varying Temperatures, in Order to Correct to 60°F.[1]

Degrees Fahrenheit	Observed degrees Baumé												
	16	18	20	22	24	26	28	30	32	34	36	38	40
30	...	1.7°	1.7°	1.7°	1.8°	1.9°	2.0°	2.0°	2.1°	2.2°	2.3°	2.3°	2.4°
35	...	1.4	1.5	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0
40	...	1.1	1.2	1.2	1.2	1.2	1.3	1.4	1.4	1.4	1.5	1.5	1.6
45	...	.8	.9	.9	.9	.9	1.0	1.0	1.0	1.1	1.1	1.2	1.2
50	...	.6	.6	.6	.6	.6	.6	.7	.7	.7	.7	.8	.8
55	...	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.4
60				Add—above this line									
60				Deduct—below this line									
65	.2	.2	.2	.3	.3	.3	.3	.3	.4	.4	.4	.4	.4
70	.5	.5	.6	.6	.6	.6	.6	.7	.7	.8	.8	.8	.8
75	.7	.8	.8	.9	.9	.9	.9	1.0	1.0	1.1	1.1	1.2	1.2
80	1.0	1.1	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.4	1.5	1.5	1.5
85	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9
90	1.6	1.6	1.7	1.7	1.8	1.8	1.9	2.0	2.0	2.1	2.1	2.2	2.3
95	1.8	1.9	1.9	2.0	2.0	2.1	2.2	2.3	2.3	2.4	2.5	2.6	2.6
100	2.1	2.2	2.2	2.3	2.3	2.4	2.5	2.6	2.7	2.7	2.8	2.9	3.0
105	2.4	2.4	2.5	2.6	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4
110	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7
115	2.9	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.1
120	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.3	4.4

Example.—What is the actual gravity of oil with an observed gravity of 30.4°Bé. at 80°F? Follow the 80°F. line along until you come to the 30°Bé. column (the nearest shown to 30.4) and note a deduction of 1.3 degrees. Actual gravity at 60°F. will be 30.4 less 1.3 or 29.1.

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[1] The figures above, with slight interpolations, have been obtained from *Circ.* 57, U. S. Standard Tables for Petroleum Oils, Bureau of Standards, U. S. Department of Commerce. For more detailed figures, the reader is referred to the circular itself, which may be obtained from the Government Printing Office, Washington, D. C.

that there are likely to be overruns or underruns, that is, excessive or deficient deliveries, to these other interests as compared with the quantities which they are entitled to receive. This is brought about by the custom of always running a full tank of oil, regardless of whether the interest is entitled to a full tank at that time. The result would be reflected in the divisional stocks at the end of the period, unless adjustment were made therefor; in fact where the system of accounting for partnership overs and shorts is imperfectly operated, stock accounts frequently are red figures as regards the proportion belonging to other interests. However, this matter is taken care of in the accounting for amounts discussed in the next section, so that the stocks at the close of the period should always be apportioned to interests, according to the respective fractional lease ownership.

Oil Production Journal Entries.—In the summary of *Amounts to be Journalized* on the reverse side of Form 8, provision has been made for three delivery quantities at various prices; the posted market price for crude oil is subject to change without notice.

At the end of an accounting period, usually a month, the following journal entries, based upon the summary, will serve to record the month's production operations:

1.	Debit—Due from Pipe Line Companies	with	Company's proportion of deliveries.
	Debit or credit—Crude Oil Stocks	with	Increase or decrease in stocks.
	Credit—Oil Earnings	with	Net revenue.

To record as an earning crude oil produced during the month of————.

2.	Debit or credit—Due from Pipe Line Companies	with	Excess or deficiency of deliveries for company
	Credit or debit—Other Interests' Overruns and Underruns	with	

To charge (or credit) pipe-line company with the excess (or deficiency) of actual deliveries for the company, as compared with this company's divisional proportion of total deliveries for the month of ————.

Crude-oil stocks should be priced at the posted market price for oil of the same quality. Any attempt to price such inventories at cost will only lead to confusion, and the result, could it be accomplished, would not be worth the labor involved.

Should an adjustment for an increase or a decrease in the market price for crude-oil stocks on hand be necessary, a separate journal entry should be made, debiting or crediting a special profit and loss account, captioned "Adjustment of Crude Oil Stocks to Market."

Gas Earnings.—Since gas earnings will form a relatively small portion of the average company's income, no special forms for recording this class of revenue are presented. Actual sales will be taken as the earning account, and should be recorded in the Lease Record (Form 2, page 85).

In the Arkansas and Louisiana fields, considerable dry gas is sold by the producers to drilling contractors, at a flat rate per day. On account of circumstances such as these, as well as the physical nature of gas, accounting for quantities usually is only partially possible, amounting often to an approximation. It is interesting to note that the laws of Oklahoma make it obligatory that all gas produced be run through properly constructed meters, and further provide that only 25 per cent of the daily natural flow of any gas well may be produced during a day. *Flambeau Lights* (gas flares) are prohibited by the laws of most of the states.

In the case of the natural-gas distributing companies, however, all intakes and deliveries are ordinarily metered, so that given a line-loss factor, based on experience, quantities may be checked with reasonable accuracy. Distributing companies are classed as public utilities. Those interested are referred to literature concerning uniform classification of gas accounts, published by the National Gas Association.

The manufacture of natural (casinghead) gasoline from casinghead gas, is discussed in Part III.

Miscellaneous Income.—Wherever the company's holdings are at all large and its operations extensive, considerable miscellaneous income will be earned. If the amounts received in the case of steam and electricity sales are comparatively insignificant, it will be found good practice to credit this income against the service or expense accounts, rather than to take it up as a separate earning.

Royalties received, when small in amount, may be taken up as miscellaneous income but, when important, are preferably included under a separate caption. It should be remembered in this connection, that depletion of the capital value of royalty holdings should not be overlooked.

It is believed that the other sources of miscellaneous income listed, are sufficiently self-explanatory to require no comment.

CHAPTER IX

GENERAL ACCOUNTING RECORDS AND CLASSIFICATION OF ACCOUNTS

Accounting in the petroleum industry is far from uniform. As far as the industry as a whole is concerned, this lack of uniformity causes no great inconvenience, although the comparative value of figures from different companies is entirely lost. Within an organization, however, inconsistency in the methods of keeping the records from year to year cannot be too emphatically condemned. The Federal tax laws have done a great deal toward impressing this fact upon oil operators; it seems so obvious that supporting argument is omitted.

For convenience, the classification of accounts appended at the end of this chapter has been followed out. The reader must not gain the impression that an attempt is being made to prescribe inflexible rules of thumb, for any classification of accounts should be so designed as to meet the conditions peculiar to the company for which the accounts are intended. Too often it is attempted to fit all operating conditions into a predesigned set of accounts, and to record the company's transactions on a stationer's *standard forms*, which may or may not have been designed by someone familiar with the industry.

It is interesting to note the very considerable differences in oil-company forms in use throughout the country. Some, of course, are well arranged and adapted to the needs of the company employing them, but the average oil-company form is open to at least one of several objections. The most common mistake seems to be that of providing for exhaustive but unessential, and frequently useless, detail. A second is an inclination toward a multiplicity of records, with several duplications of precisely the same information. A number of large producing companies are at the present time using records which are so large and unwieldy that it would not be at all absurd to provide a small overhead crane to move them about; in one instance there was observed a very detailed lease record which, when opened in all its grandeur, measured nearly 6 feet in length, and for which a special desk was set aside! The clerk working at this record called to mind Swift's description of Gulliver playing the piano in the country of the Brobdingnagians.

As a matter of fact any oil record can be conveniently arranged either on one or both sides of an 11- by 17-inch loose-leaf sheet.[1] For the sake of uniformity, the majority of the forms here presented have been prepared to these dimensions. This practice, when followed out, has the distinct advantage of making it possible for the small company to keep all or several of its records in a single binder, transferring individual records to new binders as the expansion of the business warrants; and it is believed that records of such dimensions will not be found at all inconvenient to handle in connection with any of the regular modern office equipment.

Records of an Oil Company.—The principal records of an oil producing company of average size will be somewhat as follows:

General ledger
Journal voucher
Lease record:
  Index sheet, Form 1 (page 84)
  Producing properties, Form 2 (page 85)
Voucher record, Form 3 (page 86)
Cash voucher, Form 4 (page 87)
Cash receipts, Form 5 (page 88)
Cash disbursements, Form 6 (page 89)
Payroll and teaming record, Form 7 (page 90)
Production record, Form 8 (page 91)
Wells and construction in progress, Form 9 (page 92)
Depletion record, Forms 10*a* and 10*b* (pages 93 and 94).

General Ledger.—The general and receivable ledgers should be substantial loose-leaf books, and any of the standard forms will answer the purpose. Of late years what is known as the *journal* sheet has gained in favor for general ledgers. The three- or four-cash-column pattern will be found serviceable, the actual postings debit and credit being made in the first two columns, and the last column or columns showing the ledger balance, either in one column, or debit and credit separately. By the use of this style of sheet, all entries are kept in chronological order and the taking off of periodic balances is greatly facilitated. A column of reasonable size for particulars should be provided, so that all entries, other than the totals from the cash books, voucher record, etc., can be concisely described.

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[1] The 11- by 17-inch sheet is a standard size in practically all makes of binders, and the paper is cut without any wastage from a 17- by 22-inch sheet. The smaller size, 11- by 14-inch, is also standard and a convenient-sized sheet to work with, but, in practice, is found to be too small for the necessary detail of many oil companies.

Where it is found convenient to keep sub-accounts in the general ledger, and this is often a good plan especially in the case of the smaller companies, sheets of a different color can be inserted behind the control sheet. By this method no difficulty is experienced in taking off a trial balance of the general ledger, as a result of the presence of other accounts.

Another method, previously referred to in Chap. VII, is to have the general ledger of a somewhat larger size (say, 11 by 14 inches) using the extra width for analysis columns. These columns can then be headed with the names of the sub-accounts and the whole analysis kept on the one sheet. The chief objection to this method is the necessity, where only one column is used for each sub-account, of using black and red ink for debit and credit amounts, but several companies have found the system satisfactory in spite of this objection.

Journal Voucher.—The jacket form of journal voucher is recommended, of the same size as (though a different color from) the cash voucher (Form 4). A method of numbering similar to that explained under the cash voucher, may well be adopted. With some diffidence, it is suggested that the journal itself is unnecessary. The diffidence arises from the fact that vouchers, especially in the case of oil companies, are likely to be misplaced, with consequent embarrassment. In this connection it is hardly necessary to mention that all vouchers should be in the charge of a responsible filing clerk, and that no vouchers should be removed from the files without a receipt being obtained therefor.

A method which has been found very satisfactory, avoiding as it does the keeping of a journal without the possibility of vouchers being misplaced, is to prepare all journal vouchers in duplicate. One copy, with supporting data, can then be deposited in the regular files, and the other copy placed in a post binder, from which binder all postings can be made conveniently.

Lease Record, Index Sheet.—This record was discussed in some detail in Chap. II, with especial reference to the information which it should contain. It may be mentioned that in opening a sheet of this kind for a lease, the member of the accounting staff entrusted with reading the lease agreement, as well as any other documents pertaining to the property, should have had sufficient training along these lines to enable him to recognize the salient facts. Not infrequently the failure to notice some seemingly unimportant provision of a lease agreement may result in serious financial loss to the company. In one case the president of a Texas producing company turned over a number of leases in exchange for a large block of the capital stock of the company. Careful examination of the lease agreements during an audit disclosed the fact that the leases had expired before they were turned in, such expiration being due to the failure of the first lessee to drill test wells within a specified time limit. Had the lease agreements been properly examined when the leases were acquired by the company, the mistake would have been detected immediately.

Lease Record, Producing Properties.—As in the case of the index sheet this record was taken up in detail in Chap. II, and would seem to require but little further explanation. It may be mentioned that the record should be posted direct from the vouchers; an attempt to post from the voucher record is likely to lead to the omission of important detail, or to some other serious oversight.

It seems hardly necessary to add that the record should be agreed with the general ledger controls periodically, and that the lease earnings and expense information for which space has been provided, should be balanced with both the general ledger controls and the production record (Form 8).

Voucher Record.—It is suggested that all liabilities for purchases, expenses, etc., be recorded in the voucher record, with the possible exception of such entries as those recording confidential information regarding dividends payable or transactions affecting capital stock, etc. In the case of payrolls, the most convenient method of posting is direct from a payroll summary sheet, prepared by the payroll department at the end of each pay period. There is no object to be gained by passing summarized payrolls through the voucher record.

Cash Voucher.—This form is intended to be used as a voucher jacket, to which supporting invoices and other papers may be attached with a spike fastener. Vouchers should be filed upright without folding, and in numerical order.

A system of numbering which has been found very satisfactory by several of the large companies is that of using a new series each month, designating the month by a letter, and the year by the last two digits of the year date, thus:

Voucher No. 1, for January, 1925—A 251
Voucher No. 10, for May, 1925—E 2510
Voucher No. 20, for September, 1925—K 2520

The letter "I" is seldom used on account of its similarity to the figure 1, while the letter "J" is usually reserved for general journal vouchers.

In the event that a single payment covers expenditures for several leases, the better plan is to prepare separate vouchers for each lease, with cross-reference to the voucher to which supporting papers are attached.

Cash Receipts and Cash Disbursements.—These two records are believed to be self-explanatory. It may be mentioned, however, that all cash receipts should invariably be deposited intact in the bank, all disbursements being made either by regular voucher and check or, where for petty amounts, from an imprest cash fund kept for the purpose; the periodic reimbursement of such funds should be vouchered in the ordinary way.

It will be noted that the cash disbursements record has been so arranged as to set out separately payments made in respect of three different kinds of liability, namely, vouchers payable, payroll and teaming payable, and dividends payable. The first of these accruals is built up from the amount column of the voucher record, the second direct from a payroll summary sheet, and the third by general journal entry. The number of such payable accounts in the case of any particular company, will depend largely on the volume of work and number of clerks engaged thereon.

Payroll and Teaming Record.—This record is designed to be used for all salaries and wages paid by the company, with the possible exception of office and administration salaries, and should be arranged according to locality (as leases, for example), subdivided according to classes of work. Each of the service departments should have a separate payroll.

In small companies the deduction column will not be used to any great extent, but in the larger companies, especially those operating their own commissary departments, deductions from pay may require as much accounting work as the payroll itself.

The very commendable practice of establishing a fixed payroll fund, and of maintaining this fund at the original amount by depositing the exact amount of each payroll, should be adopted. Checks can then be issued against this account to reimburse other funds for amounts due them in connection with payroll deductions; in this manner the full amount of the payroll deposit will be disbursed each period.

The Production Record, Wells and Construction in Progress Record, and Depletion Record have all been discussed fully in previous chapters, and need no further comment here.

Payroll System.—In order that the company's payroll records may be complete in every respect, considerable care should be taken that labor reports are designed in such a manner as to combine simplicity with completeness. From the standpoint of securing accurate data from the field foremen and superintendents, it is folly to install any system which is not entirely clear without more than the briefest explanation. On the other hand, there is certain information which is essential to the proper preparation of payrolls, and the correct distribution thereof. It is usually more satisfactory to require that record of each man's time be kept by a foreman or special time clerk, rather than by the individual workmen. The time card or time sheet used should show, among other things:

Workman's name and number.
Time started and stopped.
Elapsed time.
Where and how engaged.
Rate.
Amount due.

Since an adequate internal check with regard to payrolls is somewhat difficult to secure, caution should be exercised that every reasonable safeguard be used to preclude the possibility of *padding*. Individual time sheets should be approved by a foreman, and the completed payroll by the field superintendent. Where possible, the latter should pass out the checks, and periodically some one from the accounting department should undertake this work, without previous notice.

An operating company's field payroll and teaming roll is usually divisible into three classes of activity. First, there is the labor of development which, through the clearing account Drilling Department, will eventually reach the wells and construction in progress, and later either capital assets or expense according to the company's practice as regards intangible development. In the event of a dry hole, the entire expenditure on the well, less salvage, will be closed out to dry holes expense. This class of labor may be designated as *Development Labor*.

The second natural divison of labor activity will be that expended in construction work; this *Construction Labor* likewise will pass through the Wells and Construction in Progress Record, finally reaching through Uncompleted Lease Equipment or Other Uncompleted Construction, any or several of the capital asset accounts. Some companies which pursue the policy of charging intangible development to expense, also include labor on lease equipment as intangible expense.

In addition to the labor in connection with capital assets, there will be that which is directly attributable to the operation and maintenance of the properties, and which we may designate as *Operating Labor*. Accounts have been provided which separate such labor between operating and maintenance work; the cost of that lease work which is general in nature should be charged to General Lease Expense.

Authorizations for Expenditure.—In order that there may be a definite control of construction and development work, all work of this nature which is to be undertaken, and the ultimate cost of which is expected to exceed some specified amount, say $250, should be authorized on a form provided for the purpose.

In the smaller companies these authorizations will probably call for the approval of the general manager up to, perhaps, $2,500; any which are expected to cost more than that sum may require the approval of the board of directors. In the larger companies the approval of an executive committee is often necessary. It is essential that the company's executives on the spot be given reasonable authority for the purchase of leases. In a certain case a company with its directorate abroad could not purchase any leases without the approval of the board, and, as a consequence, all of the best leases in a new field were nearly always gone before the necessary authority to buy could be obtained.

No special form of authorization is suggested, but the following information should be shown:

Date,
Number,
Location of proposed work,
Nature of proposed work,
Why necessary,
Estimated cost, detailed in round figures,
Estimated time required to complete,
Estimates made by,
Approval.

A system of numbering can be devised which will indicate immediately the general nature of the work. For example the following prefixed letters might be employed:

D for development.
L for lease equipment.
O for other equipment.
WM for well maintenance (cleaning out and deepening).
LM for lease maintenance.
OM for other maintenance.

General Ledger Captions Discussed.—A card of accounts is appended at the end of this chapter, and the reader will find on studying it, that the greater portion of the accounts have already been discussed in the foregoing chapters. There are, however, some few accounts which require some further explanation.

Bonded Indebtedness.—Most oil companies at their inception are reasonably well financed, but it frequently happens that additional capital is required as new properties are acquired and developed. Although every effort should be made to secure additional share capital, rather than to float a bond issue, the company's inability to do this may make it necessary to fund indebtedness through bankers or brokers. Only at this point in its history does the average company become fully aware of the great value of correct and well-arranged accounting records, and of periodic certified balance sheets by a firm of reputable accountants.

The main accounting difficulty in connection with bonded indebtedness is the treatment of bond discount. There are various methods for amortizing the discount over the life of the bonds, which take into account the prepaid feature of the amount, figuring interest thereon; and these methods are somewhat analogous to the sinking fund method of treating depreciation. In actual practice most companies write off the discount on a straight arithmetical basis, and the following example will explain the method used.

Let us suppose that a loan of $1,000,000 has been obtained at a discount, including all expenses, of 15 per cent. The discount will amount, therefore, to $150,000. Further, the indenture provides that the bonds are redeemable after the first 10 years at the rate of 10 per cent per annum; that is, $100,000 at the end of the eleventh year, $100,000 at the end of the twelfth year, and so on.

For 11 years there will therefore be $1,000,000 of bonds outstanding, and $100,000 less during each succeeding year. The total number of years for which a single $100,000 will be outstanding is therefore as follows:

Ten	for	11 years	or	110
Nine	for	1 year	or	9
Eight	for	1 year	or	8
Seven	for	1 year	or	7
Six	for	1 year	or	6
Five	for	1 year	or	5
Four	for	1 year	or	4
Three	for	1 year	or	3
Two	for	1 year	or	2
One	for	1 year	or	1
Total				155

We can therefore divide our $150,000 discount into 155 portions, charging ten of them off each year during the first 11 years, nine off during the twelfth year, and so on, or in actual figures:

$\frac{10}{155}$ of $150,000 is	$ 9,677.42
Total for 11 years	$106,451.62
Twelfth year—$\frac{9}{155}$	8,709.67
Thirteenth year—$\frac{8}{155}$	7,741.93
Fourteenth year—$\frac{7}{155}$	6,774.19
Fifteenth year—$\frac{6}{155}$	5,806.45
Sixteenth year—$\frac{5}{155}$	4,838.71
Seventeenth year—$\frac{4}{155}$	3,870.97
Eighteenth year—$\frac{3}{155}$	2,903.23
Nineteenth year—$\frac{2}{155}$	1,935.49
Twentieth year—$\frac{1}{155}$	967.74
Total	$150,000.00

The discount can be split up in the case of any other set of circumstances along similar lines.

Purchase Money Obligations.—Where properties are purchased under an agreement which provides for a partial payment of the purchase price from the proceeds of production, the full purchase price contemplated should be set up as a purchase money obligation. This subject was dealt with in some detail in Chap. II.

Quite frequently large items of equipment are also purchased under special lien agreements; liabilities for purchases of this nature should also be classed as purchase money obligations. Tanks and tank cars, especially, are bought and sold in this manner, and it has been thought advisable to discuss some of the problems which arise in this connection later, in Part IV.

Lease Rentals.—Lease rentals are always payable in advance, and are usually paid some time before they actually fall due. As rentals are paid, they should be charged to the deferred charge account Prepaid Lease Rentals; after this they may be handled in one of two ways. The first method is to spread the rental equitably over the period covered; the second, and for conservative practice preferable, method is that of charging the amounts to expense as soon as they become due. In either event the general ledger expense account Lease Rentals should ultimately reflect the amounts paid.

The importance of prompt payment of rentals has been explained; in order to systematize the work of keeping track of the amounts due, and of insuring that none will be overlooked, it is a wise practice to maintain a card record of rentals, arranged according to due dates.

Abandoned and Canceled Leases.—To this account should be closed out all residual costs of leases which have been abandoned or canceled, for one reason or another. Care should be taken that proper explanation of the circumstances of abandonment or cancelation is entered in the Lease Record.

Dry Holes and Test Well Contributions.—This account should be charged with the cost of drilling unproductive wells, including the difference between the cost and the depreciated value of any equipment used. It should also be charged with any contributions made by the company toward the cost of drilling test wells in undeveloped territory. This latter class of expenditure is also termed Dry Hole Contributions.

Card of Accounts.—The suggested card of accounts which, as previously pointed out, should not be applied promiscuously to any particular company, is as follows:

CARD OF ACCOUNTS FOR

Capital Assets

Producing properties.
Development.
Wells in progress.
Depletion reserve (credit).

Lease equipment:
- *Derricks.*
- *Casing, tubing and rods.*
- *Pumping equipment.*
- *Line pipe and fittings.*
- *Tanks.*
- *Other equipment.*

Uncompleted lease equipment.

Other fixed assets:
- *Real estate.*
- *Permanent buildings.*
- *Temporary structures.*
- *Drilling equipment.*
- *Machine-shop equipment.*
- *Miscellaneous tools and equipment.*
- *Water wells.*
- *Water and gas lines.*
- *Engineering and laboratory equipment.*
- *Telephone and telegraph facilities.*
- *Automobiles and trucks.*
- *Live stock and vehicles.*
- *Furniture and fixtures.*

Other uncompleted construction.

Depreciation reserve (credit).

Undeveloped properties.

Investments

Investments in and advances to affiliated companies.[1]
Other securities owned.
Cash in escrow.
Sinking fund deposits.

Current Assets

Material stores.
Crude oil stocks.
Notes receivable.
Due from pipe-line companies.
Other interests' overruns and underruns.
Miscellaneous accounts receivable.
Reserve for doubtful accounts (credit).
Due from employees.
United States Government securities.
Cash in banks.
Petty cash funds.

Deferred Charges

Prepaid lease rentals.
Unexpired insurance premiums.
Prepaid interest.
Unamortized expense on capital and bond issues.
Miscellaneous prepaid expense.

Capital and Liabilities

Capital stock, preferred.
Capital stock, common.
Bonded indebtedness.
Purchase money obligations.
Notes payable, banks.
Notes payable, others.
Vouchers payable.
Payroll and teaming payable.
Dividends payable.
Interest accrued.
Taxes accrued.
Other accrued expenses.
Provision for Federal income tax.
Reserve for contingencies.
Capital surplus.
Earned surplus.
Dividends paid.
Profit and loss.

A PRODUCING COMPANY

INCOME AND EXPENSE

Income:

- Oil earnings.
- Gas earnings.
- Other lease earnings.
- Royalties received.
- Rent earnings.

- Investment income, affiliated companies.
- Investment income, other
- Interest on Government securities.

- Miscellaneous income.

Depletion.

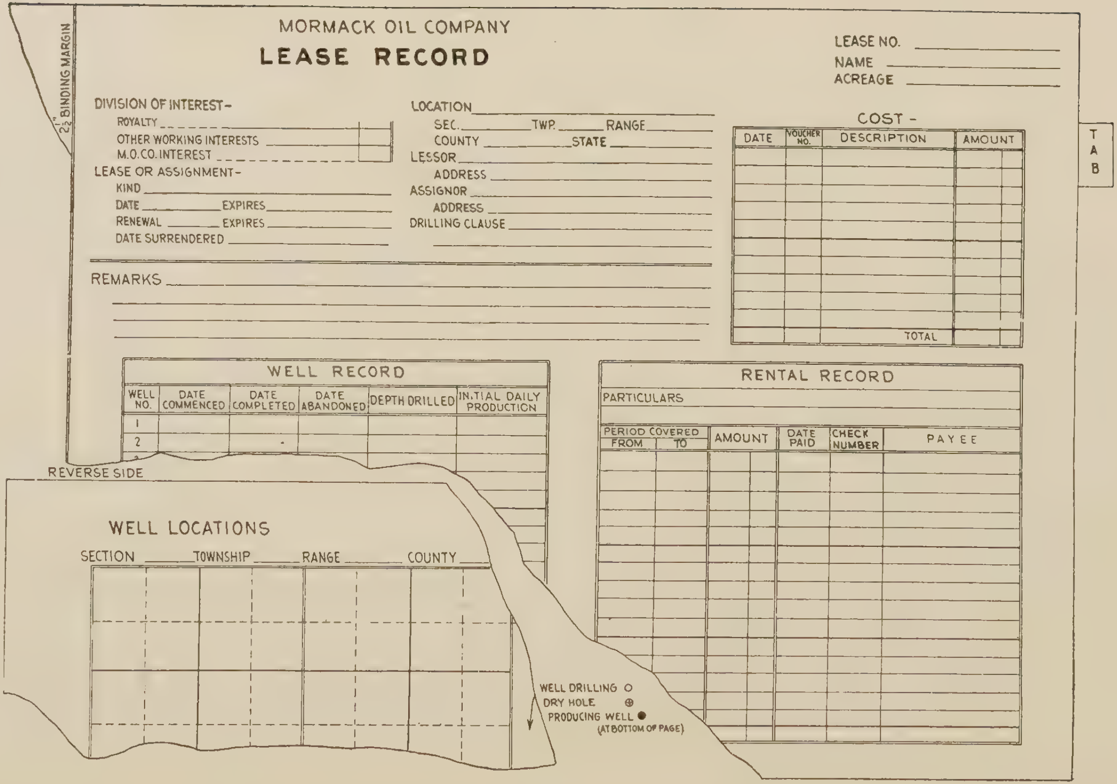
Service department income and expense:

- Drilling department.
- Warehouse department.
- Engineering and geological department.
- Garage and stable department.

Expenses:

- Production expenses:
  - Pumping labor and expense.
  - Depreciation.
  - Maintenance expense:
    - *Labor.*
    - *Repair parts and expense.*
    - *Cleaning out and deepening.*
  - General lease expense.
- Administrative:
  - *Management salaries.*
  - *Office salaries.*
  - *Office supplies and expense.*
  - *Heat and light.*
  - *Telephone, telegraph and postage.*
  - *Traveling and automobile expense.*
  - *Charitable contributions.*
  - *General taxes.*
  - *Legal and auditing expense.*
  - *Miscellaneous.*
- General:
  - Lease rentals.
  - Abandoned and canceled leases.
  - Provision for contingencies.
  - Dry holes and test well contributions.
  - Income taxes.
  - Interest.

(Note.—All sub-accounts above are shown in italics.)



2½" BINDING MARGIN

MORMACK OIL COMPANY

LEASE RECORD

LEASE NO. ________
NAME ________
ACREAGE ________

TAB

DIVISION OF INTEREST–
ROYALTY ________
OTHER WORKING INTERESTS ________
M.O.CO. INTEREST ________
LEASE OR ASSIGNMENT–
KIND ________
DATE ______ EXPIRES ______
RENEWAL ______ EXPIRES ______
DATE SURRENDERED ________

LOCATION ________
SEC. ______ TWP. ______ RANGE ______
COUNTY ______ STATE ______
LESSOR ________
ADDRESS ________
ASSIGNOR ________
ADDRESS ________
DRILLING CLAUSE ________

COST –

DATE	VOUCHER NO.	DESCRIPTION	AMOUNT
		TOTAL	

REMARKS ________

WELL RECORD

WELL NO.	DATE COMMENCED	DATE COMPLETED	DATE ABANDONED	DEPTH DRILLED	INITIAL DAILY PRODUCTION
1					
2					

RENTAL RECORD

PARTICULARS

PERIOD COVERED FROM	PERIOD COVERED TO	AMOUNT	DATE PAID	CHECK NUMBER	PAYEE

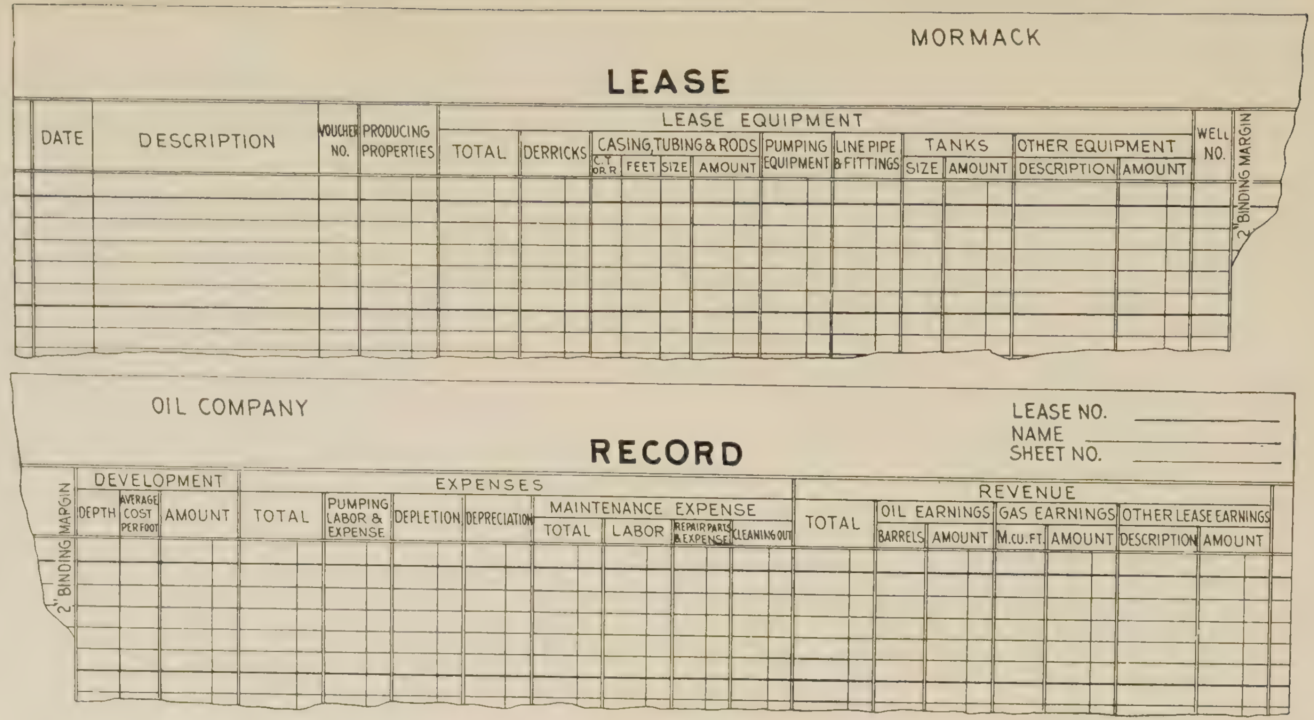
REVERSE SIDE

WELL LOCATIONS

SECTION ______ TOWNSHIP ______ RANGE ______ COUNTY ______

WELL DRILLING ○
DRY HOLE ⊕
PRODUCING WELL ●
(AT BOTTOM OF PAGE)

FORM 1.—Production department—lease record, index sheet. (17 × 11 in. Loose leaf.)



MORMACK

LEASE

DATE	DESCRIPTION	VOUCHER NO.	PRODUCING PROPERTIES	LEASE EQUIPMENT													WELL NO.	2" BINDING MARGIN
				TOTAL	DERRICKS	CASING, TUBING & RODS				PUMPING EQUIPMENT	LINE PIPE & FITTINGS	TANKS		OTHER EQUIPMENT				
						C.T. OR R	FEET	SIZE	AMOUNT			SIZE	AMOUNT	DESCRIPTION	AMOUNT			

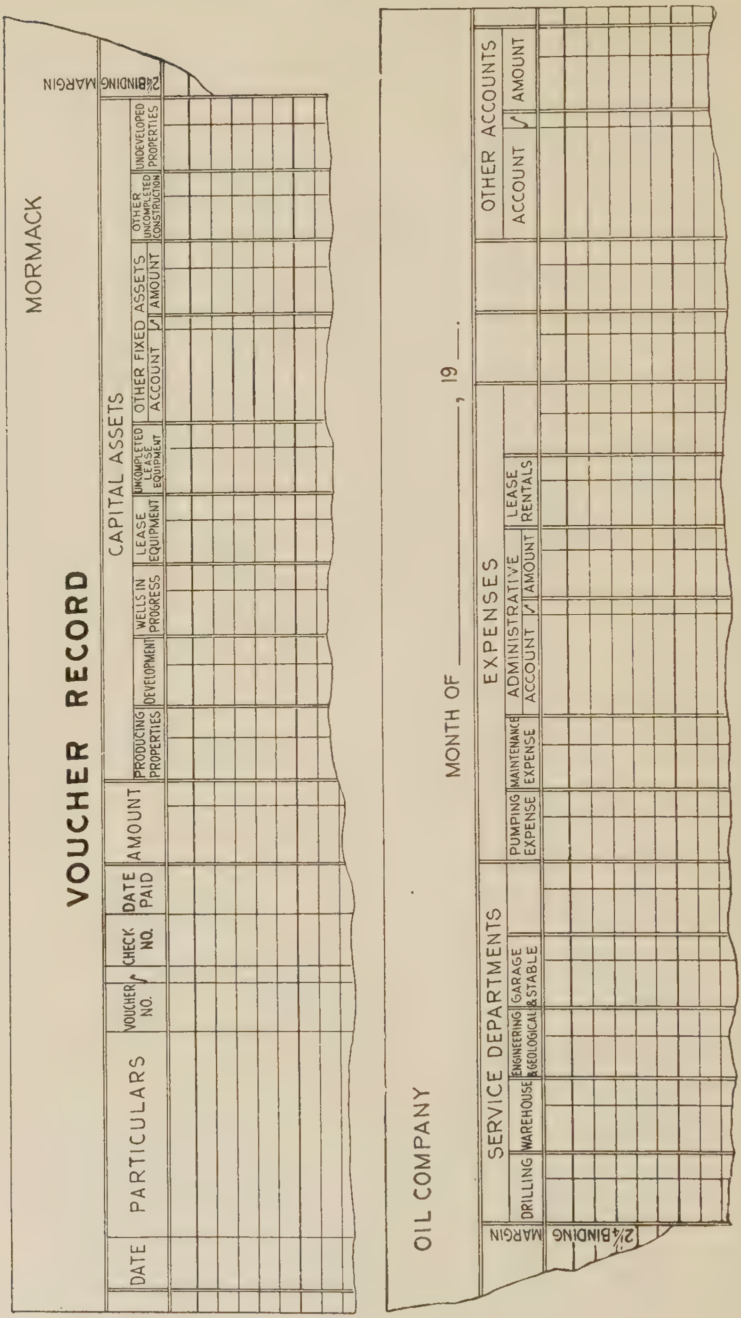
OIL COMPANY

RECORD

LEASE NO. ____________
NAME ____________
SHEET NO. ____________

2" BINDING MARGIN	DEVELOPMENT			EXPENSES									REVENUE							
	DEPTH	AVERAGE COST PER FOOT	AMOUNT	TOTAL	PUMPING LABOR & EXPENSE	DEPLETION	DEPRECIATION	MAINTENANCE EXPENSE					TOTAL	OIL EARNINGS		GAS EARNINGS		OTHER LEASE EARNINGS		
								TOTAL	LABOR	REPAIR PARTS & EXPENSE	CLEANING OUT			BARRELS	AMOUNT	M.CU.FT.	AMOUNT	DESCRIPTION	AMOUNT	

Form 2.—Production department—lease record for producing properties. (17 × 11 in. Loose leaf.)



MORMACK OIL COMPANY

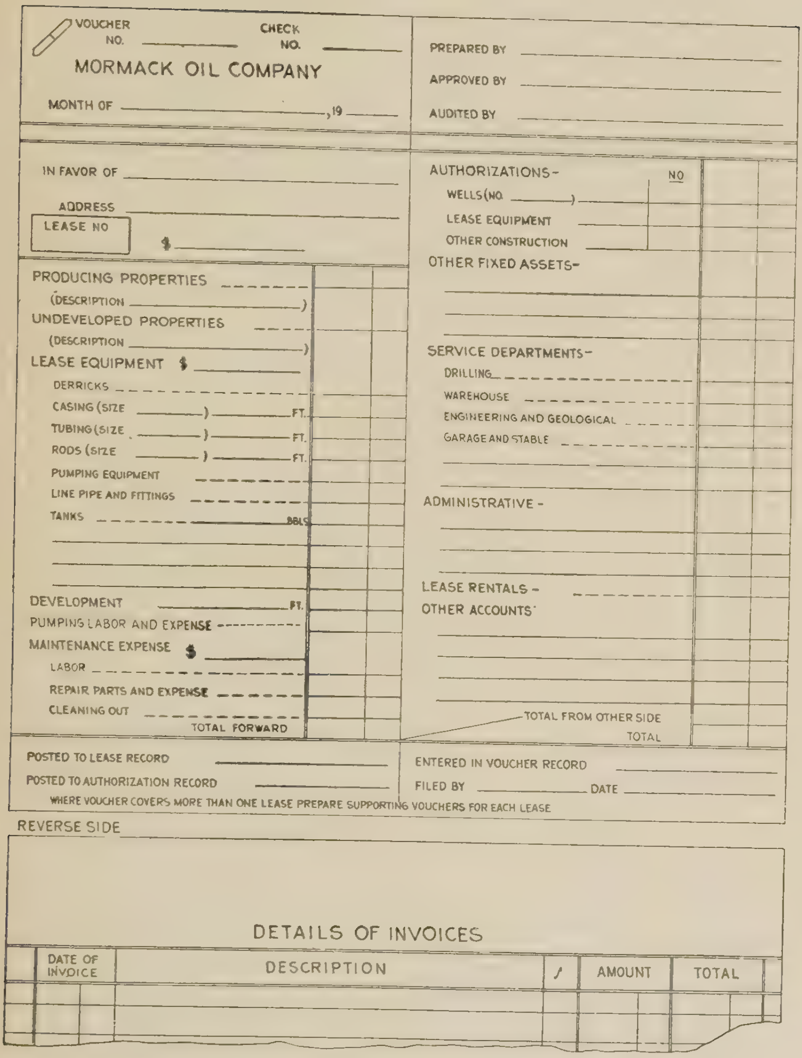
VOUCHER RECORD

MONTH OF ____________, 19___.

DATE	PARTICULARS	VOUCHER NO.	✓	CHECK NO.	DATE PAID	AMOUNT	CAPITAL ASSETS										2¼ BINDING MARGIN
							PRODUCING PROPERTIES	DEVELOPMENT	WELLS IN PROGRESS	LEASE EQUIPMENT	UNCOMPLETED LEASE EQUIPMENT	OTHER FIXED ASSETS			OTHER UNCOMPLETED CONSTRUCTION	UNDEVELOPED PROPERTIES	
												ACCOUNT	✓	AMOUNT			

MARGIN 2¼ BINDING	SERVICE DEPARTMENTS					EXPENSES										OTHER ACCOUNTS		
	DRILLING	WAREHOUSE	ENGINEERING & GEOLOGICAL	GARAGE & STABLE		PUMPING EXPENSE	MAINTENANCE EXPENSE	ADMINISTRATIVE			LEASE RENTALS					ACCOUNT	✓	AMOUNT
								ACCOUNT	✓	AMOUNT								

FORM 3.—Production department—voucher record. (17 × 11 in. Loose leaf.)



VOUCHER NO. CHECK NO.

MORMACK OIL COMPANY

MONTH OF , 19

PREPARED BY

APPROVED BY

AUDITED BY

IN FAVOR OF

ADDRESS

LEASE NO

$

PRODUCING PROPERTIES

(DESCRIPTION)

UNDEVELOPED PROPERTIES

(DESCRIPTION)

LEASE EQUIPMENT $

DERRICKS

CASING (SIZE) FT.

TUBING (SIZE) FT.

RODS (SIZE) FT.

PUMPING EQUIPMENT

LINE PIPE AND FITTINGS

TANKS BBLS

DEVELOPMENT FT.

PUMPING LABOR AND EXPENSE

MAINTENANCE EXPENSE $

LABOR

REPAIR PARTS AND EXPENSE

CLEANING OUT

TOTAL FORWARD

AUTHORIZATIONS - NO

WELLS (NO.)

LEASE EQUIPMENT

OTHER CONSTRUCTION

OTHER FIXED ASSETS -

SERVICE DEPARTMENTS -

DRILLING

WAREHOUSE

ENGINEERING AND GEOLOGICAL

GARAGE AND STABLE

ADMINISTRATIVE -

LEASE RENTALS -

OTHER ACCOUNTS

TOTAL FROM OTHER SIDE

TOTAL

POSTED TO LEASE RECORD

POSTED TO AUTHORIZATION RECORD

ENTERED IN VOUCHER RECORD

FILED BY DATE

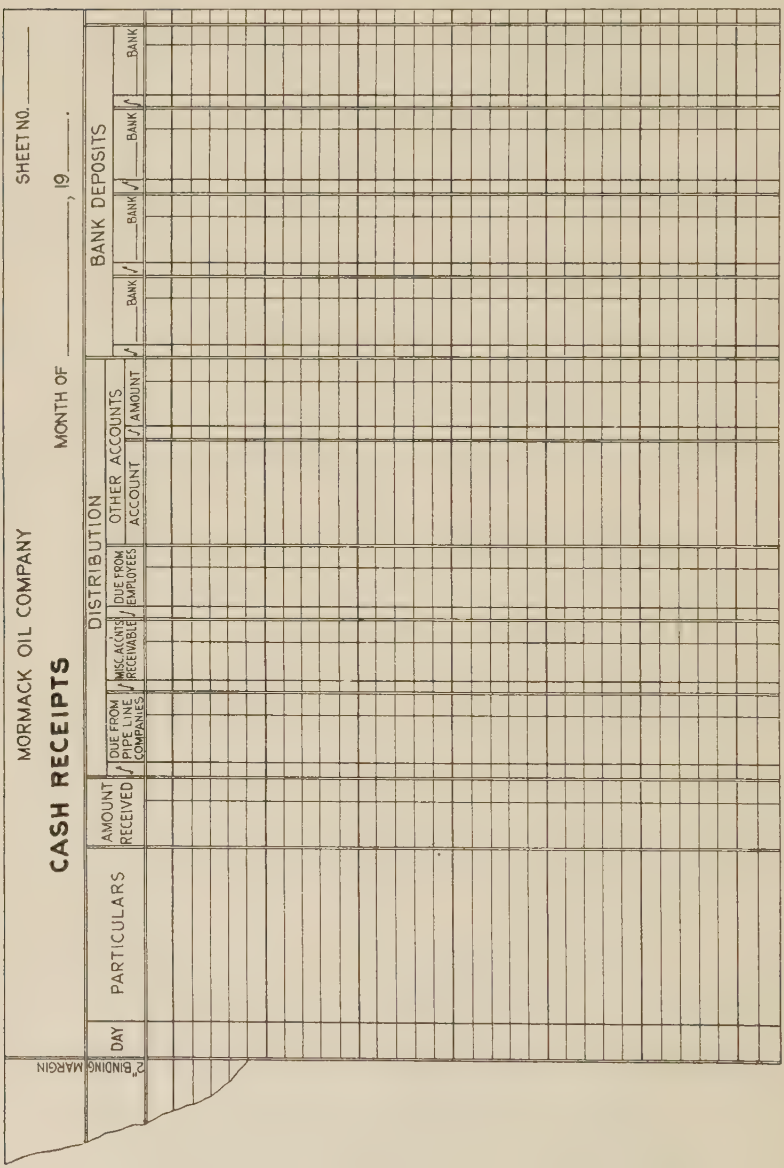
WHERE VOUCHER COVERS MORE THAN ONE LEASE PREPARE SUPPORTING VOUCHERS FOR EACH LEASE

REVERSE SIDE

DETAILS OF INVOICES

DATE OF INVOICE	DESCRIPTION	✓	AMOUNT	TOTAL

FORM 4.—Production department—cash voucher. (8½ × 9¼ in.)



MORMACK OIL COMPANY

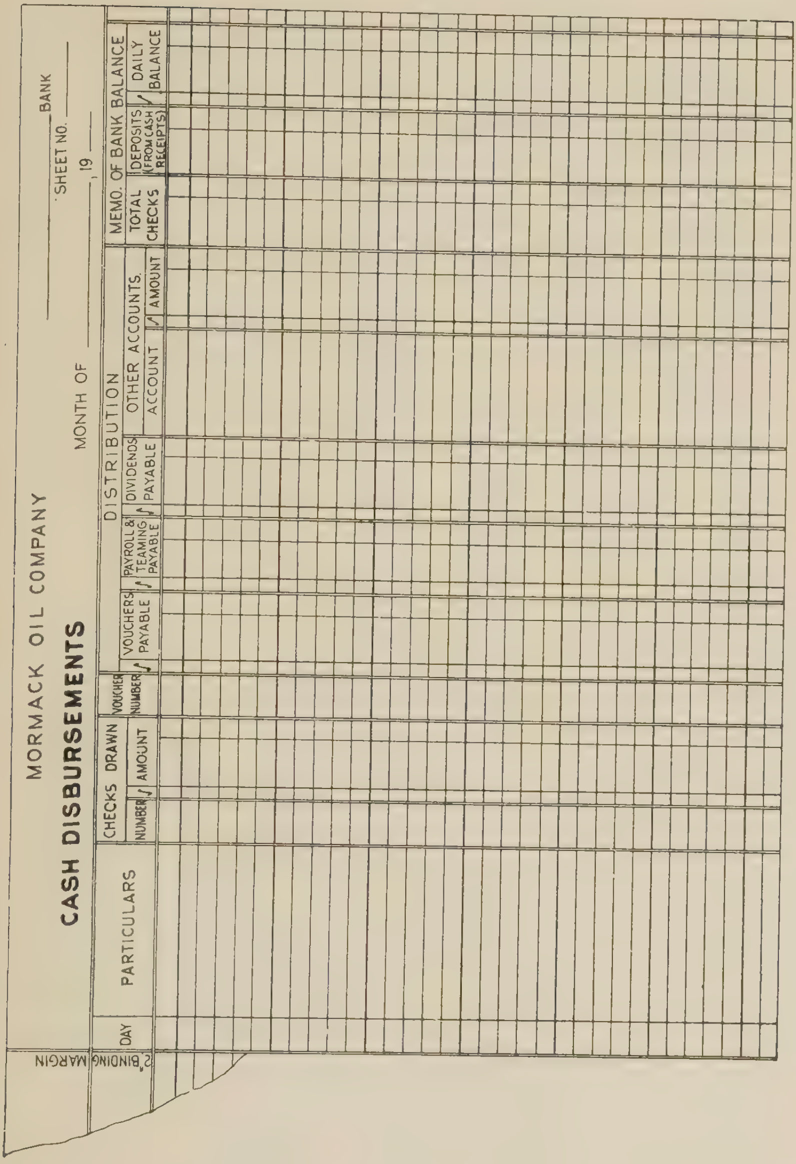
SHEET NO.______

CASH RECEIPTS

MONTH OF ____________, 19____.

2" BINDING MARGIN	DAY	PARTICULARS	AMOUNT RECEIVED	✓	DISTRIBUTION									BANK DEPOSITS							
					DUE FROM PIPE LINE COMPANIES	✓	MISC. ACC'NTS RECEIVABLE	✓	DUE FROM EMPLOYEES	OTHER ACCOUNTS											
										ACCOUNT	✓	AMOUNT	✓	______ BANK	✓	______ BANK	✓	______ BANK	✓	______ BANK	

Form 5.—Production department—cash receipts. (17 × 11 in. Loose leaf.)



MORMACK OIL COMPANY

CASH DISBURSEMENTS

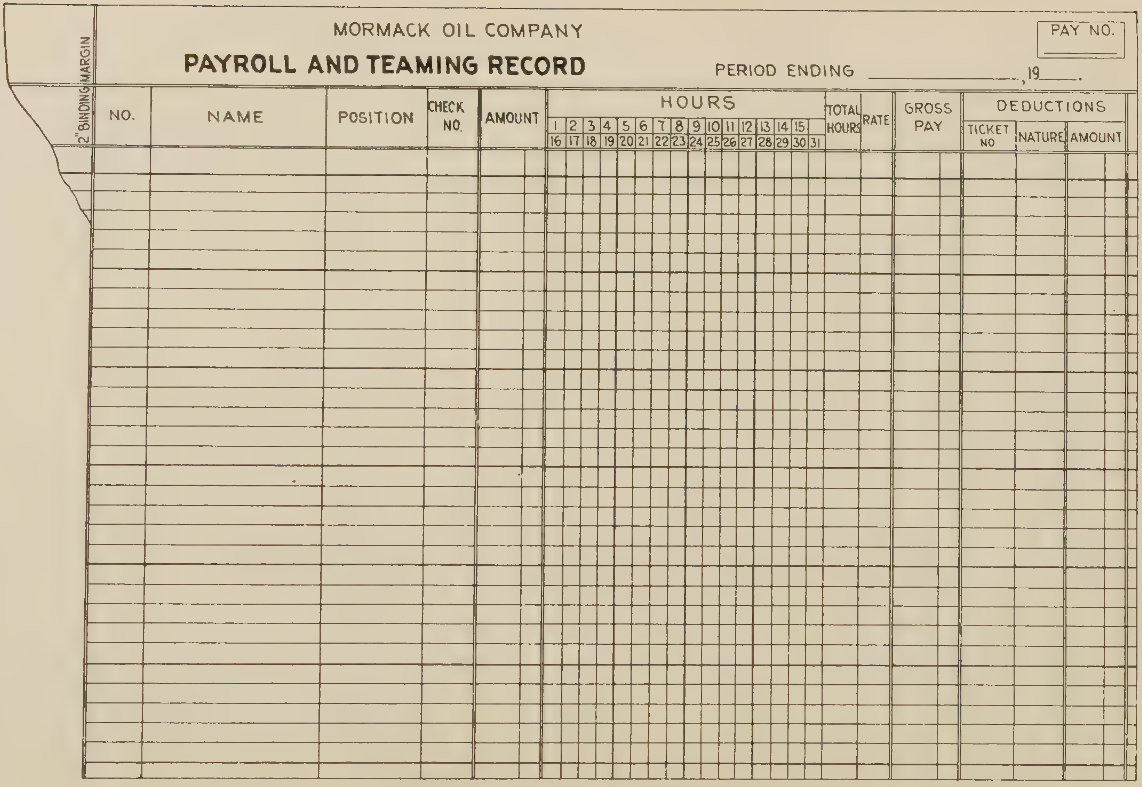
MONTH OF ________, 19__

SHEET NO. ____

________ BANK

2" BINDING MARGIN	DAY	PARTICULARS	CHECKS DRAWN			VOUCHER NUMBER	DISTRIBUTION									MEMO. OF BANK BALANCE			
			NUMBER	✓	AMOUNT		✓	VOUCHERS PAYABLE	✓	PAYROLL & TEAMING PAYABLE	✓	DIVIDENDS PAYABLE	OTHER ACCOUNTS			TOTAL CHECKS	DEPOSITS (FROM CASH RECEIPTS)	✓	DAILY BALANCE
													ACCOUNT	✓	AMOUNT				

FORM 6.—Production department—cash disbursements. (17 × 11 in. Loose leaf.)



MORMACK OIL COMPANY

PAYROLL AND TEAMING RECORD

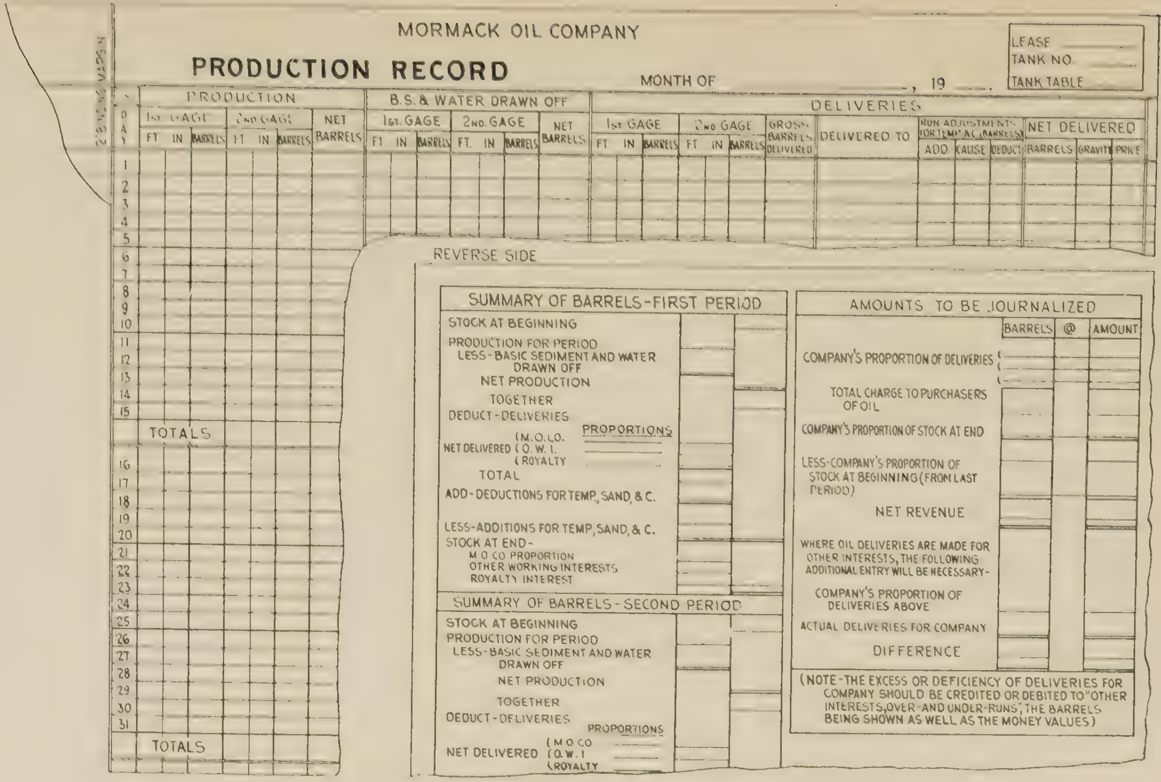
PERIOD ENDING ________, 19___.

PAY NO. ____

2" BINDING MARGIN

NO.	NAME	POSITION	CHECK NO.	AMOUNT	HOURS																TOTAL HOURS	RATE	GROSS PAY	DEDUCTIONS		
					1 16	2 17	3 18	4 19	5 20	6 21	7 22	8 23	9 24	10 25	11 26	12 27	13 28	14 29	15 30	 31				TICKET NO	NATURE	AMOUNT

FORM 7.—Production department—payroll and teaming record. (17 × 11 in. Loose leaf.)



MORMACK OIL COMPANY

PRODUCTION RECORD

MONTH OF ______________, 19___.

LEASE ______
TANK NO ______
TANK TABLE ______

DAY	PRODUCTION							B.S. & WATER DRAWN OFF							DELIVERIES													
	1st GAGE			2nd GAGE			NET BARRELS	1st GAGE			2nd GAGE			NET BARRELS	1st GAGE			2nd GAGE			GROSS BARRELS DELIVERED	DELIVERED TO	RUN ADJUSTMENTS FOR TEMP. &C. (BARRELS)			NET DELIVERED		
	FT	IN	BARRELS	FT	IN	BARRELS		FT	IN	BARRELS	FT	IN	BARRELS		FT	IN	BARRELS	FT	IN	BARRELS			ADD	CAUSE	DEDUCT	BARRELS	GRAVITY	PRICE
1																												
2																												
3																												
4																												
5																												
6																												
7																												
8																												
9																												
10																												
11																												
12																												
13																												
14																												
15																												
	TOTALS																											
16																												
17																												
18																												
19																												
20																												
21																												
22																												
23																												
24																												
25																												
26																												
27																												
28																												
29																												
30																												
31																												
	TOTALS																											

REVERSE SIDE

SUMMARY OF BARRELS-FIRST PERIOD

STOCK AT BEGINNING
PRODUCTION FOR PERIOD
LESS-BASIC SEDIMENT AND WATER DRAWN OFF
NET PRODUCTION
TOGETHER
DEDUCT-DELIVERIES
PROPORTIONS
NET DELIVERED (M.O.CO. ______
(O.W.I. ______
(ROYALTY ______
TOTAL
ADD-DEDUCTIONS FOR TEMP, SAND, & C.
LESS-ADDITIONS FOR TEMP, SAND, & C.
STOCK AT END-
M.O.CO PROPORTION
OTHER WORKING INTERESTS
ROYALTY INTEREST

SUMMARY OF BARRELS-SECOND PERIOD

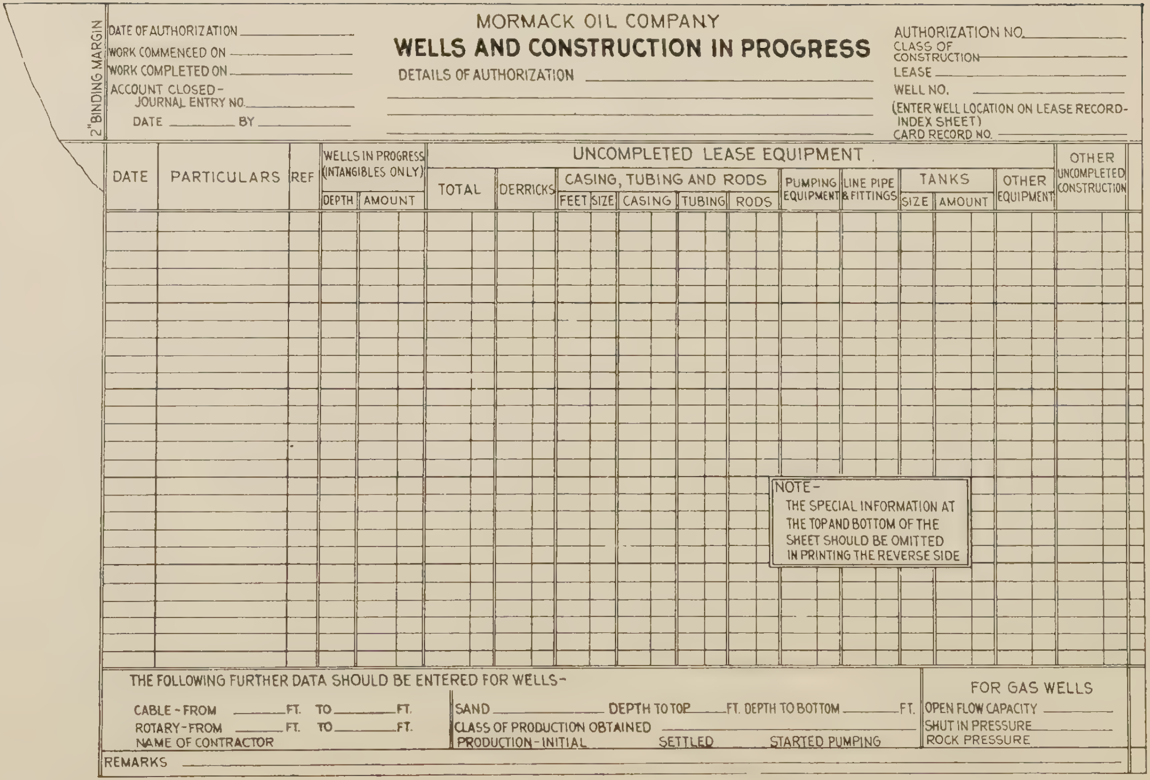
STOCK AT BEGINNING
PRODUCTION FOR PERIOD
LESS-BASIC SEDIMENT AND WATER DRAWN OFF
NET PRODUCTION
TOGETHER
DEDUCT-DELIVERIES
PROPORTIONS
NET DELIVERED (M.O.CO ______
(O.W.I ______
(ROYALTY ______

AMOUNTS TO BE JOURNALIZED

	BARRELS	@	AMOUNT
COMPANY'S PROPORTION OF DELIVERIES (			
(			
(			
TOTAL CHARGE TO PURCHASERS OF OIL			
COMPANY'S PROPORTION OF STOCK AT END			
LESS-COMPANY'S PROPORTION OF STOCK AT BEGINNING (FROM LAST PERIOD)			
NET REVENUE			
WHERE OIL DELIVERIES ARE MADE FOR OTHER INTERESTS, THE FOLLOWING ADDITIONAL ENTRY WILL BE NECESSARY-			
COMPANY'S PROPORTION OF DELIVERIES ABOVE			
ACTUAL DELIVERIES FOR COMPANY			
DIFFERENCE			

(NOTE-THE EXCESS OR DEFICIENCY OF DELIVERIES FOR COMPANY SHOULD BE CREDITED OR DEBITED TO "OTHER INTERESTS, OVER-AND UNDER-RUNS", THE BARRELS BEING SHOWN AS WELL AS THE MONEY VALUES)

FORM 8. Production department—production record. (17 × 11 in. Loose leaf.)



2" BINDING MARGIN

DATE OF AUTHORIZATION ____
WORK COMMENCED ON ____
WORK COMPLETED ON ____
ACCOUNT CLOSED-
JOURNAL ENTRY NO. ____
DATE ____ BY ____

MORMACK OIL COMPANY

WELLS AND CONSTRUCTION IN PROGRESS

DETAILS OF AUTHORIZATION ____

AUTHORIZATION NO. ____
CLASS OF CONSTRUCTION ____
LEASE ____
WELL NO. ____
(ENTER WELL LOCATION ON LEASE RECORD-INDEX SHEET)
CARD RECORD NO. ____

DATE	PARTICULARS	REF	WELLS IN PROGRESS (INTANGIBLES ONLY)		UNCOMPLETED LEASE EQUIPMENT													OTHER UNCOMPLETED CONSTRUCTION
					TOTAL	DERRICKS	CASING, TUBING AND RODS					PUMPING EQUIPMENT	LINE PIPE & FITTINGS	TANKS		OTHER EQUIPMENT		
			DEPTH	AMOUNT			FEET	SIZE	CASING	TUBING	RODS			SIZE	AMOUNT			

NOTE-
THE SPECIAL INFORMATION AT THE TOP AND BOTTOM OF THE SHEET SHOULD BE OMITTED IN PRINTING THE REVERSE SIDE

THE FOLLOWING FURTHER DATA SHOULD BE ENTERED FOR WELLS-

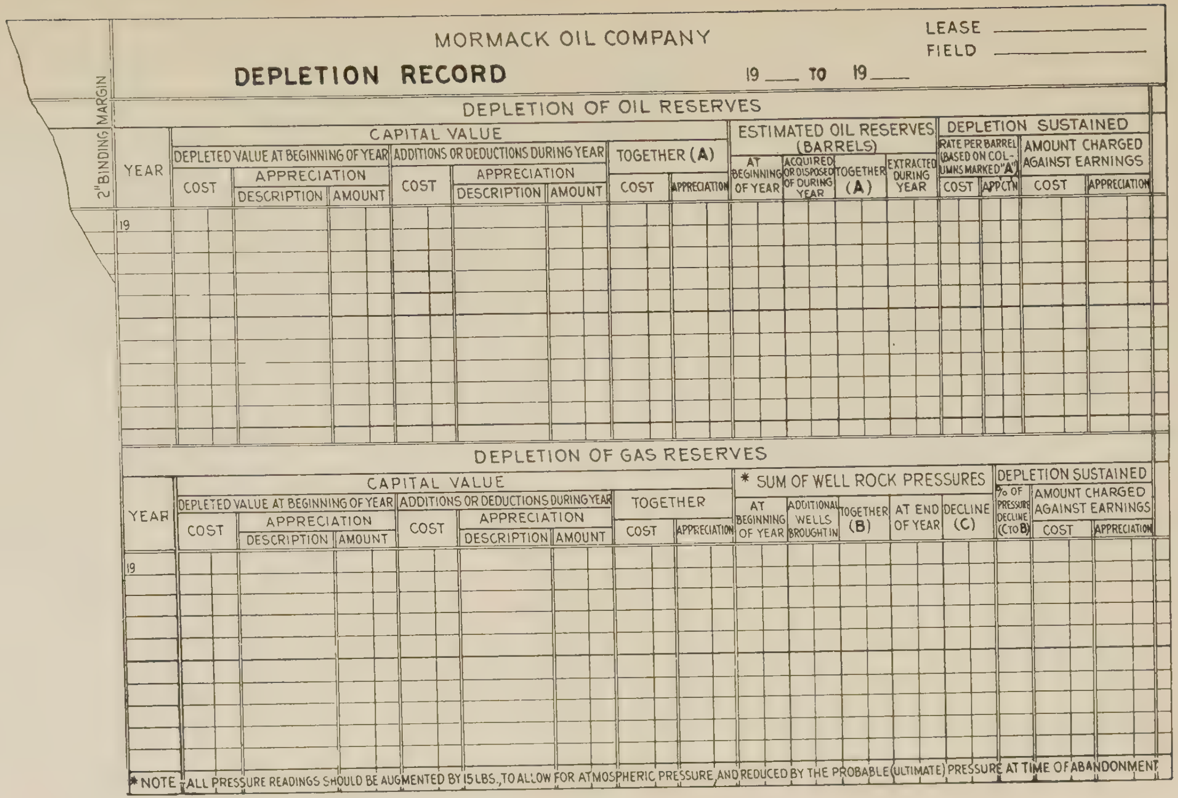
CABLE-FROM ____ FT. TO ____ FT.
ROTARY-FROM ____ FT. TO ____ FT.
NAME OF CONTRACTOR

SAND ____ DEPTH TO TOP ____ FT. DEPTH TO BOTTOM ____ FT.
CLASS OF PRODUCTION OBTAINED ____
PRODUCTION-INITIAL SETTLED STARTED PUMPING

FOR GAS WELLS
OPEN FLOW CAPACITY ____
SHUT IN PRESSURE ____
ROCK PRESSURE

REMARKS ____

Form 9.—Production department—wells and construction in progress. (17 × 11 in. Loose leaf.)



MORMACK OIL COMPANY

LEASE ____________

FIELD ____________

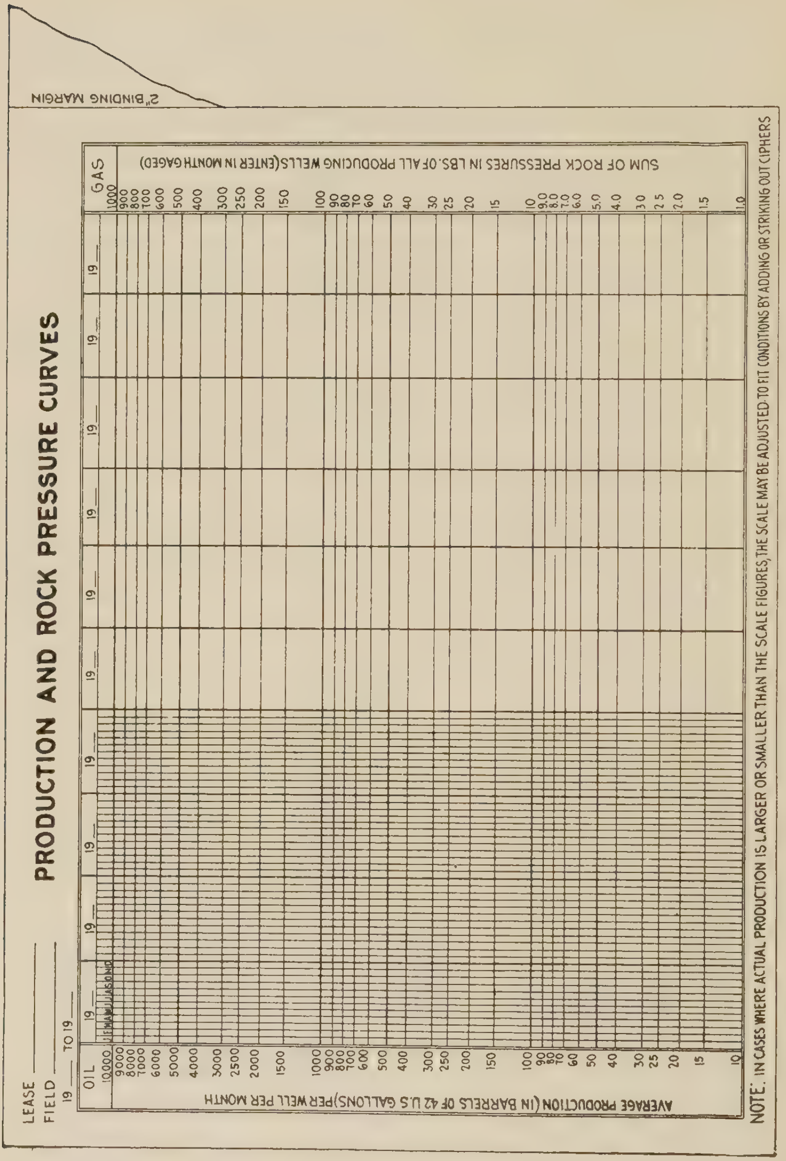
DEPLETION RECORD 19___ TO 19___

2" BINDING MARGIN

DEPLETION OF OIL RESERVES																
YEAR	CAPITAL VALUE								ESTIMATED OIL RESERVES (BARRELS)				DEPLETION SUSTAINED			
	DEPLETED VALUE AT BEGINNING OF YEAR			ADDITIONS OR DEDUCTIONS DURING YEAR			TOGETHER (A)		AT BEGINNING OF YEAR	ACQUIRED OR DISPOSED OF DURING YEAR	TOGETHER (A)	EXTRACTED DURING YEAR	RATE PER BARREL (BASED ON COLUMNS MARKED "A")		AMOUNT CHARGED AGAINST EARNINGS	
	COST	APPRECIATION		COST	APPRECIATION		COST	APPRECIATION					COST	APPCTN	COST	APPRECIATION
		DESCRIPTION	AMOUNT		DESCRIPTION	AMOUNT										
19																
DEPLETION OF GAS RESERVES																
YEAR	CAPITAL VALUE								* SUM OF WELL ROCK PRESSURES					DEPLETION SUSTAINED		
	DEPLETED VALUE AT BEGINNING OF YEAR			ADDITIONS OR DEDUCTIONS DURING YEAR			TOGETHER		AT BEGINNING OF YEAR	ADDITIONAL WELLS BROUGHT IN	TOGETHER (B)	AT END OF YEAR	DECLINE (C)	% OF PRESSURE DECLINE (C TO B)	AMOUNT CHARGED AGAINST EARNINGS	
	COST	APPRECIATION		COST	APPRECIATION		COST	APPRECIATION							COST	APPRECIATION
		DESCRIPTION	AMOUNT		DESCRIPTION	AMOUNT										
19																

* NOTE — ALL PRESSURE READINGS SHOULD BE AUGMENTED BY 15 LBS., TO ALLOW FOR ATMOSPHERIC PRESSURE, AND REDUCED BY THE PROBABLE (ULTIMATE) PRESSURE AT TIME OF ABANDONMENT.

Form 10*a*.—Production department—depletion record. (17 × 11 in. Loose leaf.)



2" BINDING MARGIN

LEASE ____
FIELD ____
19 ____ TO 19 ____

PRODUCTION AND ROCK PRESSURE CURVES

19__ J F M A M J J A S O N D
19__
19__
19__
19__
19__
19__
19__

OIL
10,000 9000 8000 7000 6000 5000 4000 3000 2500 2000 1500 1000 900 800 700 600 500 400 300 250 200 150 100 90 80 70 60 50 40 30 25 20 15 10

AVERAGE PRODUCTION (IN BARRELS OF 42 U.S GALLONS) PER WELL PER MONTH

GAS
1000 900 800 700 600 500 400 300 250 200 150 100 90 80 70 60 50 40 30 25 20 15 10 9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.5 2.0 1.5 1.0

SUM OF ROCK PRESSURES IN LBS. OF ALL PRODUCING WELLS (ENTER IN MONTH GAGED)

NOTE: IN CASES WHERE ACTUAL PRODUCTION IS LARGER OR SMALLER THAN THE SCALE FIGURES, THE SCALE MAY BE ADJUSTED TO FIT CONDITIONS BY ADDING OR STRIKING OUT CIPHERS

FORM 10*b*.—Production department—depletion record (reverse side). (17 × 11 in. Loose leaf.)

PART II

TRANSPORTATION, TREATMENT AND STORAGE

CHAPTER X

OUTLINE OF PRACTICE

When it is realized that the average production of crude oil in the United States is between a million and a half and two million barrels per day, it is not difficult to believe that the division of the oil industry which moves, treats, and stores the oil, is of no small importance.

There are at the present time approximately 60,000 miles of trunk lines in the United States and about 135,000 tank cars. The latter means of transportation is relatively unimportant in connection with crude oil, for although in some instances it may, for various reasons, be transported by tank car, by far the larger proportion (probably as much as 95 per cent) of America's production is moved through pipe lines. It is difficult to obtain any reliable figures as to the total storage facilities of the various tank farms throughout the country, but it is safe to assert that there is sufficient to accommodate well over six months' production; the average time that production is stored is estimated in the mid-continent field, for example, at a little over five months.

Tank car transportation as well as that done by tank steamer is, for the purposes of this volume, treated as marketing; some interesting problems in this connection are dealt with in Part IV.

Transportation by Pipe Line.—The Tarr Farm pipe line, laid more than fifty years ago, may be said to have been the first step in the development of an industry of national importance. Today great trunk lines extend from all the principal oil fields to refineries many miles distant, as well as to the sea ports on the Atlantic and Gulf coasts.

As explained in Part I, the pipe-line companies usually receive the oil into their lines directly from the tank of the producer. A gage is made of the contents of the tank, both before and after the oil has been run, and the particulars of these gages are entered on run tickets prepared by the representatives of both parties. A form of Run Ticket for the producer has already been presented (Fig. 4, page 66), and the *Gage Ticket* to be used by the pipe-line company's representative will contain practically the same information (see Form 20, page 140).

From the viewpoint of the transporting company the transaction is either a direct purchase of the oil, or acceptance thereof for transportation and delivery at a fixed point, with possibly storage for a lesser or greater period. In the case of purchased oil, accounting will be made at stated intervals, usually monthly. Most pipe-line companies render statements every 15 days, one copy being sent to each party who has an interest in the production. Checks may be mailed with the statements, but are more often sent out monthly.

Since the purchasing company is charged with the proper division of the proceeds from the production of a lease, between the various parties interested, care should be exercised that payments are made only on *division orders*. It is essential that these division orders record the authenticated share to which each party is entitled. In many cases payments must be deposited in escrow by the pipe-line company, awaiting such time as satisfactory proof concerning the ownership of the oil is forthcoming.

Pipe lines may be broadly divided as to *gathering lines* and *trunk lines*. The gathering lines, as the name implies, extend from the main lines to the various points from which the oil is collected. These points are usually the storage tanks of the producers with which the pipe-line company has contracts to purchase oil. From the producers' tanks the oil is pumped into the gathering line and thence finds its way into the trunk line.

In order to move the oil through the pipe line, *booster stations* must be situated at convenient points along the lines; at these stations pumping facilities, together with one or more large storage tanks, are maintained. The distance between the stations is dependent upon the viscosity of the oil being moved and the topography of the country through which the lines run, as well as upon the type of pumping equipment in use. This distance varies from about 12 miles or less to as much as 60 miles, and in districts where very thick oil is handled, as for example in Mexico, it may be necessary to heat the oil at the booster stations in order to reduce its viscosity. There are a few lines which are used only for transporting light oils; consequent upon the ease with which such oil is handled, the stations are often as much as 90 miles apart.

Although technical detail were better left to those works dealing with operating procedure, it may be in order to present a few of the more interesting data, in a non-technical manner. Authorities state that the best working line-pressure is about 750 pounds per square inch, and that on this basis an 8-inch pipe line will deliver in the neighborhood of 14,000 barrels of 35°Bé. oil per day.

Pipe lines vary in size, but the ordinary sizes in use are 4, 6, 8, 10, and 12 inches, the dimensions representing approximately the internal diameter of the line. The cost will vary considerably in different localities; the cost of laying 6- and 8-inch line per mile over flat country will be about $7,500 and $10,000 respectively, and these costs will probably be divisible somewhat as follows:

	Per Cent
Pipe	60
Freight	12
Labor	18
Survey and right of way	3
Other	7
	100

As pipe-line operating costs in different localities are widely divergent, no attempt is made to state any exact figure, though it probably will be between the limits of 4 and 10 cents per 100 barrels per mile.[1]

It is often difficult to ascertain the exact volumetric content of a line, for accounting purposes; given however the linear length of the line, the approximate content can be computed from the following table.[2] Strictly speaking, adjustment of line content should be made, day by day, to allow for the actual temperature of the oil, and for the line pressure. It may be stated, though, that except in long lines of large bore, the adjustment in this connection will not be large (see table on page 68):

---

[1] As estimated by Cross, Roy, *Bull.* 16, Kansas City Testing Laboratory.

[2] The figures in the table are calculated on the assumption that the pipe sizes represent their inside diameters, and that 1 cubic foot is equal to 7.481 U. S. gallons. In actual fact, lines of different weights and makes vary somewhat in diameter, although the differences are not very great. If greater accuracy is desired, the content of the actual pipe may be arrived at by adjusting the volumes shown, in proportion to the squares of the pipe diameters. If, for example, the actual pipe has an internal diameter of 8.4 inches, the content per mile will be 328 barrels (content for 8 inches) multiplied by 70.56 (square of 8.4) and divided by 64 (square of 8).

Size of Pipe, Inches	U. S. Gallons per Foot	U. S. Barrels per Mile
3	.3672	46
4	.6528	82
5	1.020	128
6	1.469	185
7	1.999	251
8	2.611	328
9	3.305	415
10	4.080	513
11	4.937	621
12	5.875	739
13	6.896	867
14	7.997	1,005
15	9.181	1,154

Treatment of Oil.—As has been mentioned, most oil producers now treat their oil before marketing it. This treatment is designed to remove basic sediment and water, both of which elements are undesirable in an oil. Where production is marketed without treatment, the buyer usually makes a deduction from the quantity run, paying only for the net quantity. This deduction is termed a *pipe-line allowance;* in the mid-continent field, where the established allowance is 3 per cent,[1] the field tanks are strapped to show only the net oil, that is, 97 per cent of the actual quantity.

Considerable dehydration is done by means of heating the oil up to temperatures as high as 200°F., by passing it through hot water. The losses are so great by this method, however, that it is not recommended by authorities. The subject of evaporation losses is treated of in the last section of this chapter.

The other three principal methods of dehydration are chemical, centrifugal, and electrolytic.

Chemical Treatment.—By a chemical method recently patented, and which has proved highly successful, the oil from the well is pumped through a *tret-o-lizer*, and thence into the settling tank. The treated oil enters the settling tank at the bottom, the oil rising to the top and the separated water and sediment settling to the bottom of the tank. This method is said to have made possible the reclamation during a single year of fifty million barrels of oil which would otherwise have been entirely lost.

---

[1] Two per cent in Texas.

Centrifugal Treatment.—The de Laval Crude Oil Purifier, which employs the centrifugal principle, is coming into general use. It is claimed for this process that it is not necessary to heat the oil to such a high temperature, nor to keep it heated for so long a time, as is necessary in the ordinary steaming and settling processes, thus reducing evaporation losses.

Electrolytic Treatment.—It is said that the Cottrell and Speed electric precipitation method is both effective and economical, one kilowatt of current being sufficient to treat 10 barrels of oil. The free water having been drawn from the oil, the petroleum is pumped into vertical cylinders 3 feet in diameter and 12 feet high. These cylinders are fitted with especially constructed electrodes and, upon the introduction of an electrical current of from 10,000 to 15,000 volts, the minute drops of water in suspension, acting as conductors of the current, form themselves chain-like between the electrodes. As the drops grow larger they detach themselves and sink to the bottom of the cylinders.[1]

Storage of Oil.—Storing crude petroleum and its products presents some unusual and important problems. In the early days it was customary to run production into almost anything which would act as a container. Earthen pits, sometimes concrete lined but oftener not, were frequently utilized. As a matter of fact, this type of temporary storage is still used, though usually only in cases of emergency. Most storage, both in the case of crude oil and refined products, is now done in steel tanks ranging in capacity from 1,000 to 55,000 barrels. The following table shows the dimensions and capacity of the principal sizes of tanks in use:

---

[1] According to BAÇON and HAMOR, "American Petroleum Industry."

Capacity, barrels of 42 gallons	Dimensions in feet		Approximate barrels per inch
	Diameter	Height	
55,000	114½	30	152.80
37,500	95	30	105.20
30,000	85	30	84.24
25,000	75	30	65.57
20,000	70	30	57.12
15,000	60	30	41.98
10,000	50	30	29.15
5,000	35	30	14.28
2,000	35	12	
1,700	35	10	
3,800	30	30	10.50
3,200	30	25	
2,500	30	20	
1,250	30	10	
1,000	30	8	
760	30	6	
2,000	25	25	7.29
1,500	25	17½	
875	25	10	
1,000	20	20	4.66
500	20	10	

In connection with tank capacities, the following formula may be found of use:

Barrels per vertical inch = $(\text{Diameter in feet})^2 \times .011658$.[1]

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[1] The mathematician will like to check this formula by the following stages:

$$
\begin{aligned}
\text{Surface area of oil in feet} &= (\text{Diameter in feet})^2 \times \frac{\pi}{4} \\
\text{Volume per inch in cubic feet} &= (\text{Diameter in feet})^2 \times \frac{\pi}{4} \times \frac{1}{12} \\
\text{Gallons per inch} &= (\text{Diameter in feet})^2 \times \frac{\pi}{4} \times \frac{1}{12} \times 7.481 \\
\text{Barrels per inch} &= (\text{Diameter in feet})^2 \times \frac{\pi}{4} \times \frac{1}{12} \times 7.481 \times \frac{1}{42} \\
&= (\text{Diameter in feet})^2 \times \frac{3.1416 \times 7.481}{4 \times 12 \times 42} \\
&= (\text{Diameter in feet})^2 \times \frac{23.5023096}{2{,}016} \\
&= (\text{Diameter in feet})^2 \times .011658.
\end{aligned}
$$

Steel tanks are ordinarily erected by the manufacturer, under a contract which provides that the material be delivered f.o.b. a point near the tank site; the buyer prepares the tank site, and transports the material thereto at his own expense. The tank consists of a series of curved plates from 5 to 6 feet in width, 15 to 20 feet in length and from $\frac{3}{16}$ to $\frac{1}{2}$ inch in thickness; 55,000-barrel tanks have either five or six rings of these plates, while those of 80,000-barrel capacity have seven or eight rings. A complete 55,000-barrel tank weighs approximately 200 tons; from this it will be realized that carelessness in setting the concrete foundation, or in the riveting and calking work on the tank proper, may cause considerable trouble especially since some 8,000 to 9,000 additional tons will be contained within the tank when it is filled.

Storage tanks, as well as the various kinds of temporary reservoirs, are usually grouped together on what are known in the industry as *tank farms.* In order to protect the remainder of the tanks from a fire which may start at any point on the farm, circular earthwork levees, called *fire-walls,* are constructed around each tank. These levees are generally of a size sufficient to hold the entire contents of a single tank, thus tending to prevent the spread of fire in the event of a conflagration. It may be mentioned that tank farms, for obvious reasons, seem to be the pet objective of lightning.

These farms usually contain about twenty-five 55,000-barrel tanks to each 160 acres of land, the distance from center to center being about 500 feet, and from shell to shell about 400 feet. Most companies maintaining tank farms are careful to provide ample fire protection systems, both in the way of preventative measures and fire fighting apparatus. Of the latter, one method which has proved successful and economical is that in which two chemicals are pumped into a mixing chamber on the tank; the chemicals form a viscous foam containing free carbonic acid gas which effectually smothers the fire.

Most present-day storage is done in steel-roofed tanks, and attention is being directed toward improving existing facilities to a point where losses from evaporation will be minimized.

Evaporation Losses.—The subject of evaporation losses is somewhat technical, but so much attention has been given recently to its very serious aspects, that a page or two here is devoted to its consideration. A very valuable account of a series of experiments made recently under the direction of the United States Bureau of Mines is contained in their *Bull.* 200, by J. H. Wiggins, entitled "Evaporation Loss of Petroleum in the Mid-Continent Field." The information in the following paragraphs has been summarized in large measure from this bulletin.

At first thought losses from evaporation would seem relatively unimportant, especially in view of the immense volume of production which is now being obtained. It should be remembered, however, that the most volatile, and consequently the most valuable, products evaporate first.[1] The following estimate of lease storage evaporation losses in the Mid-continent field, at different seasons of the year, during the average storage period of 5 days, will serve to convey some idea of the enormity of such losses:

Season	Mid-continent production, barrels	Average volume lost, per cent	Actual volume lost, gallons	Value lost considered as gasoline
January, February and December	45,000,000	1.14	21,540,000	$ 4,740,000
March, April, May, October and November	78,400,000	1.40	46,120,000	10,150,000
June, July, August and September	72,200,000	1.80	54,520,000	11,990,000
Whole year (1919)	195,600,000		122,180,000	$26,880,000

Evaporation and seepage losses may be broadly classified as to cause:

1. Leaks: Poor connections, loosened calking, corroded bottom plates, etc.

2. Spray: The wasteful practice of filling tanks, tank cars and other containers by allowing the oil to pour in from the top.

3. Ebullition: The bubbling which takes place when oil is pumped in from the bottom of the tank.

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[1] The gravity of evaporating gases has been estimated to vary from 67 to 81°Bé.

4. Evaporation: Some losses from this cause are unavoidable, but improved methods of storing and handling will reduce them to a large extent.

Such losses as arise from poor pipe connections, loosened calking and like causes are inexcusable, since the causes are remediable with only ordinary maintenance work. Corrosion of tank-bottom plates may be forestalled by covering the concrete foundation upon which the tank rests with several inches of oil-soaked sand. This must be done, of course, before the erection of the tank; several coats of rust- and alkali-resisting paint should be applied to the tank bottom before lowering the tank upon its foundation.

The former practice of filling tanks by allowing the oil to spray in from the top, is rapidly becoming a thing of the past. Losses from this source have been estimated to be as high as from 1 to 2 per cent, and are increased by a high wind or an unusually hot day. In modern practice, tanks are filled from the bottom by pumping the oil in; losses from ebullition are reduced to a minimum by the use of gas-tight roofs.

Such evaporation as takes place from still oil surfaces is attributable to a number of contributing factors. A great deal of research work has been undertaken by the Bureau of Mines in this connection, and some surprising results are being accomplished. It has been found that light-colored tanks, tending to reflect the rays of the sun, show a smaller percentage of loss than black tanks. In some cases a shelter somewhat in the nature of a shed, protecting the tank from direct sunshine and moving air currents, has been found very effective; several companies have an arrangement which can be operated to throw a continuous spray of water on the tank roof, thus keeping down its temperature. Most tanks are now made with gas-tight tops, and a slight pressure, regulated by valves, is maintained within the tank.

The following table, prepared as a result of the series of experiments by the Bureau of Mines, showing the estimated evaporation losses on every barrel of oil during its progress from the well to the refinery, is of considerable interest. From a study of the text it appears, moreover, that the figures shown are likely to be somewhat less than the actual facts:

Location of loss	Evaporation losses, per cent			
	Summer	Autumn and spring	Winter	Average
Flow or settling tank	1.2	1.0	.8	1.0
Filling lease tank	1.2	1.0	.8	1.0
Lease storage	1.8	1.4	1.2	1.5
Gathering	1.3	.9	.8	1.0
Transportation	1.2	.9	.8	1.0
Tank farms	.9	.7	.6	.7
Totals	7.6	5.9	5.0	6.2

The diagram opposite (Fig. 5) showing the course of oil from the producing field to storage in the tank farm, will serve to make clearer the different stages through which the oil travels before reaching storage.

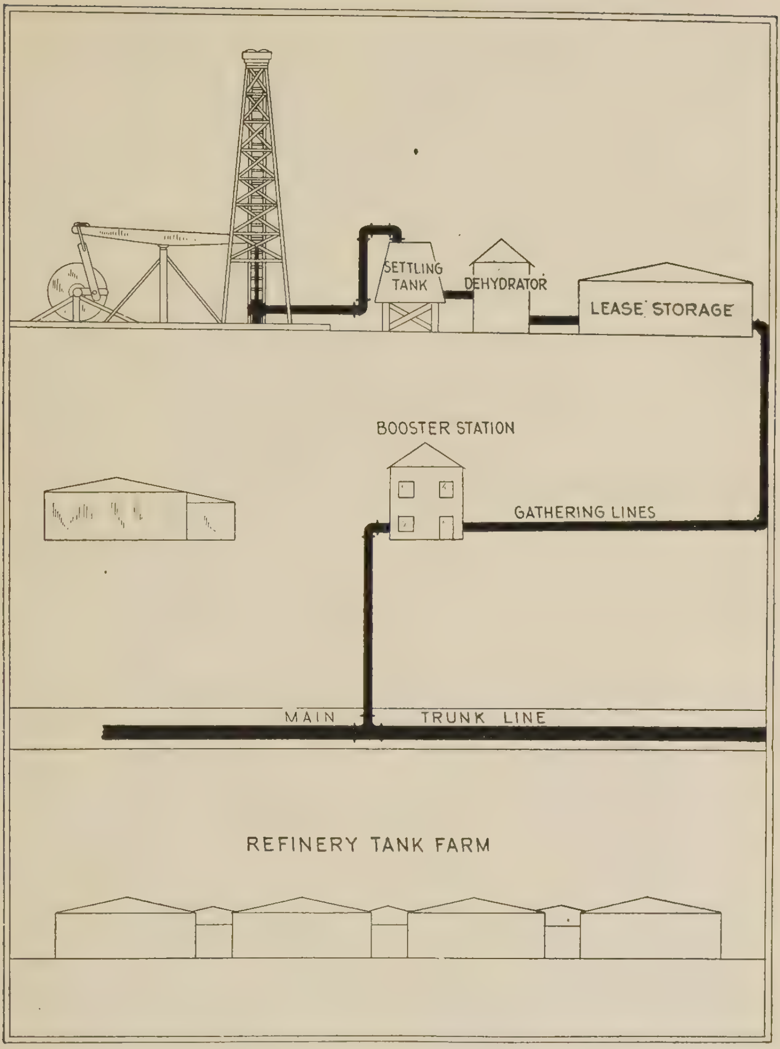

FIG. 5.—Diagram of course of oil from field to storage.

CHAPTER XI

OIL MOVEMENT REPORTS

The activities of a pipe-line company are divisible into two main classes. In the first of these, the purchase, transportation, and resale of oil, the company acts as principal; in the second, transportation for hire, the relationship of bailment arises between the shipper and the transporting company. Since it is necessary that careful account be kept of the oil in both cases, well-arranged records have come to occupy as important a place in pipe-line organizations as any other part of the company's equipment.

It has been somewhat difficult to arrange a set of oil movement records which are generally applicable to an average pipe-line company, for the reason that methods and arrangements of facilities are so varied. In devising the appended forms, the case of a company has been assumed which collects untreated oil into a central tank farm, afterwards treating it and delivering either to the company's own refinery or to outside parties. With very slight revision, however, the forms can be adapted to suit any particular conditions.

The forms have been so designed that a daily balance of all oil received and delivered is maintained, and the amount of any losses ascertained daily; the advantages that are to be gained by this daily balancing are obvious and need not be enlarged upon here. The purchases and sales journals are integral parts of the system, as is also the register of bailment (called *carrier*) oil, so that when once a balance has been struck, all the records will be known to be in agreement.

The following is a list of the forms which will be used to record oil movements; it will be noted that some of these records will also constitute a portion of the general accounting records:

Gage ticket, Form 20 (page 140)
Crude purchase journal, Form 12 (page 132)
Register of carrier oil, Form 13 (page 133)
Tank farm daily report, Form 14 (page 134)

Crude sales journal, Form 15 (page 135)
Summary of oil receipts and deliveries, Form 11 (page 130).

An explanation of the uses of the forms is appended.

Gage Ticket (Form 20).—Just as is the case with oil producing companies, the gage ticket provides the greater part of the information concerning the company's operations. When oil is purchased from the producer at his lease, or is taken into the lines for conveyance to some other point, the tank from which the oil is withdrawn is gaged before and after the run. The difference between these two gages, after they have been converted to equivalent barrels and adjusted for temperature differences, represents the quantity of oil run into the pipe line. The gage tickets upon which the gage has been recorded are forwarded to the accounting department.

In addition to gaging the tanks of the producers from whom purchases are made, it is also necessary that the company's own storage tanks be gaged. Since tanks for temporary storage are maintained at most of the pumping (booster) stations along the lateral and trunk lines, each of these stations must prepare gage tickets for transmission to the accounting department. In the same manner, gage tickets must also be prepared at the company's main tank farm.

Different forms of gage tickets might be employed for these different purposes, but it is thought that the one form may very well answer the purpose, and that the transactions may be distinguished, either by variously colored tickets or, as shown on the form, by designating letters prefixed to the ticket numbers (or both).

The "P" series may be used for outright purchases of oil from producers and others, and will form the original record from which the crude purchase journal is prepared.

The "CR" and "CD" series will be used for receipts and deliveries of carrier oil, thus keeping them distinct from outright purchases and sales; from these tickets the register of carrier oil will be prepared.

The "B" and "T" series will be used by the booster stations and tank farm respectively, for recording their intake and deliveries; from these tickets the tank farm daily report will be prepared. As separate provision for the changes in booster station stocks is made on the daily oil summary, the "B" tickets should not be entered on the same summary sheet as the "T" tickets.

The "DO" series is intended to be used when basic sediment, water and other impurities are drawn off, at the tank farm or treating plant. It is not intended that this series be used at the booster stations; any impurities drawn off in transit will naturally be reflected in the summary, as intake line losses. This suggestion is merely for the sake of simplicity. These tickets will also be summarized on the tank farm daily report.

The final "S" series will be used for all sales outside the organization, as well as for deliveries to the company's own refinery, wharves, etc. Strictly speaking, oil used for fuel should also be reported on an "S" ticket. From a practical point of view, however, operating conditions are such that accurate information in this respect is not obtainable. The better plan is to require a monthly estimate from each station, of the quantity of oil used for fuel. Journal entry can then be made, charging a fuel used expense account and crediting one or another of the oil loss accounts.

There is only one type of storage for which tickets are not provided, that is, for the oil which is contained in the lines. It will be noted that spaces are provided on the gage ticket, on the "Received from" and "Delivered to" sides, for "Line emptied" and "Line filled," respectively. Such entries will not be of very common occurrence, and a sheet of the tank farm daily report can be used for the line stocks, new sheets being prepared only when any changes take place.

There are a few other explanations with regard to the gage ticket which should be made:

1. The *Lines* might well be numbered in order to avoid a considerable amount of writing each day, and it may be repeated that the *Line emptied* and *Line filled* spaces are only to be used when lines are emptied without being refilled with oil, or where empty lines are filled from the company's oil stocks.

2. *Delivery Instructions* (Name, Location and Date for delivery) are for use with the "CR" series of tickets only, and the *Owner* line, lower down, is provided so that the carrier oil may retain its identity.

3. It will be noted that *Temperature Correction* space is provided in the case of each gage. This is for use, of course, only in the case of the large storage tanks; in all other cases one temperature correction computed on the net barrels will be sufficient.

4. The *Deductions for Impurities* line is to be used only in the case of purchases and sales, in order to agree the barrellages with actual quantities for which payment is to be made. In the case of purchases, the net agreed barrels will be the amount to be entered in the purchase journal, and any subsequent overage will be absorbed in the intake line loss figure; in the case of sales, however, the "net barrels" will be shown as tank farm runs, and the "net agreed barrels" as oil sold (see Form 11*a*).

5. Tables have already been included in Chap. VIII (pages 68 and 69), from which the volume *Corrections for Temperature and Gravity* can readily be figured.

Crude Purchase Journal (Form 12).—As previously stated, this record will be entered up from the "P" series of gage tickets; the daily totals will be carried to the summary of oil receipts and deliveries. The record also provides a basis for entry to the detailed crude oil purchase accounts payable. In connection with this posting, see Chap. XIII.

Register of Carrier Oil (Form 13).—This register will be entered up originally from the "CR" series of tickets; the tank farm intake tickets later will furnish information as regards the date received at the tank farm, and in which tank the oil is stored; the deliveries will come from the "CD" ticket series. Charges to the owners of the oil for transportation and storage will also be entered herein, which entries will form the basis for the preparation of the bills to the owners.

It will do no harm to repeat that this record, under the system suggested, will form an integral part of the daily oil balancing. It should therefore be kept up to date just as carefully as any of the other records entering into the summary of oil movements.

Tank Farm Daily Report (Form 14).—In order that accurate data may be had concerning the quantity of oil received, transported and delivered, the tank farm daily report must be carefully kept. Provision has been made, in the form here presented, for a complete accounting of all oil stocks. After having brought forward the contents of a tank as shown by the previous gage report, the present gages should be entered in their respective columns and adjusted to 60°F. Where no pumping in or out of the tank has taken place during the interval between the gage brought forward and the present first gage, any difference should be entered in the *Evaporation Losses* column.

The net barrels intake or delivery will be represented by the difference between the converted first and second gages; this difference should be analyzed in the last three columns of the form, care being taken that proper explanation is inserted in the space provided therefor.

The tank farm daily report should be prepared at the tank farm office, from the individual gage tickets, the tickets and report then being forwarded to the accounting department. Care should be taken that any transfers of oil between tanks at the farm, show the same barrelages delivered from one tank as are taken into the other. Any tanks in the treating department should be considered as part of the tank farm group, and for this reason the foregoing remark is equally applicable to oil transferred to and from the treating department. Losses resulting from treating should be recorded on "DO" tickets, and entered in the last column of the tank farm daily report as "B. S. and Water drawn off."

As previously explained, the booster station tickets will be summarized on a tank farm daily report sheet, but this summarizing should be done in the accounting office, from the "B" tickets. The record of oil in lines, kept on a tank farm daily report sheet, will also be made up in the accounting office.

Crude Sales Journal (Form 15).—The functions of this record are apparent from a study of the form itself. The actual barrels shown on the "S" ticket, as agreed with the party to whom the oil is sold, will be entered herein and postings will be made direct from the record to the personal account of the purchaser.

It will be noted that three columns have been provided under both "Oil sold" and "Amount." These columns can be headed with the captions most convenient for the particular company for which the record is used.

Summary of Oil Receipts and Deliveries (Forms 11*a* and 11*b*). This summary acts as a master sheet for all oil movement reports, and its preparation should only be entrusted to an employee who is thoroughly familiar with operating conditions.

Receipts.—The total gaged quantity of oil purchased during the day should be entered in the first column of this form, together with the cost thereof, when the company's accounting practice records the latter. This information will be obtained from the crude purchase journal, into which latter record gage tickets of purchases will have been posted in detail. The quantity of carrier oil which was received into the lines during the day for transportation, will be secured from the register of carrier oil. From information furnished by the tank farm daily report summarizing the gage tickets rendered by the various pumping stations at which storage tanks are situated, changes in station stocks will be entered in the columns provided therefor.

Since the company's lines are full of oil, the net barrels of oil pumped into storage will be represented by the quantity of oil purchased, plus carrier oil taken for transportation, plus or minus decreases or increases in station stocks, respectively. The quantity thus determined, however, will fail to agree with the gaged tank farm intake by the amount of losses arising from seepage, etc. From the tank farm daily report compiled by the company's tank farm, the actual intake to storage should be entered in the proper column; care should be taken that the explanations of losses are genuine, for it is not at all unusual for lines to be tapped and large quantities of oil stolen.[1] These losses should be entered in the differences column.

Deliveries.—All deliveries of oil should be gaged; deliveries may be classified as follows, and with a few exceptions will be made from the main tank farm:

Oil sold.
Oil delivered to the company refinery.
Oil delivered to bailors for whom it has been transported.
Oil delivered into empty lines.

Where deliveries are made from different units of the organization, as for example, from wharves or loading racks, gaging will be necessary at the point of final delivery, as well as at the tank farm. This procedure will disclose certain losses arising from evaporation and leakage; any differences between tank farm runs and gaged deliveries should be entered in the column provided.

The information concerning oil sold, either to outsiders or to the company's refinery, will be obtained from the crude sales journal. All deliveries of oil should be passed through this record, with the exception of carrier oil deliveries. The latter will be contained in the register of carrier oil.

Care should be exercised that all large losses are explained, for the percentage of ordinary evaporation loss should remain practically constant at all times, with only some little variation during different seasons of the year. The subject of evaporation losses has been discussed in Chap. X.

Tank Farm Losses.—The tank farm losses will be of two kinds. Those arising from the drawing off, or removal by dehydration, of water and sediment, will be readily determinable by gage. All other losses, arising from leaks, breaks, fires, etc. should be entered in the column headed "Other" under tank farm losses, with proper explanation.

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[1] In one case in Kentucky a pipe line traversed a thinly settled and mountainous region in the course of its route to the tank farm. A new superintendent, having taken charge of the company's field operations, decided to inspect all of the trunk lines. Upon reaching a point some 50 miles into the hills, however, he was met by an individual who explained, at the point of a Winchester, that his presence was highly undesirable. Subsequent investigation revealed a well-organized method of stealing oil in large quantities.

Oil Stocks.—The quantity of oil on hand, divisible as between tank farm, stations, and lines, should be entered in the summary of oil receipts and deliveries each day; these figures will be obtained from the second gages shown on the tank farm daily report sheets.

It is not suggested that every tank be gaged daily, except when a change in the contents takes place. In the discretion of the field superintendent, physical inventory will no doubt be taken at regular intervals, though from the point of view of a correct monthly statement of accounts, gages might well be taken on the last day of each calendar month.[1]

Total Losses.—The losses sustained during the period should be analyzed as to the divisions of the organization in which they occurred; provision has been made for carrying over the information into one total figure, in the form here presented.

Summary for Month.—In order that all oil movements during the period may be balanced, the summary shown on Form 11*b* should be filled in carefully. The following is a brief explanation of the procedure which should be followed in preparing this summary:

> To the inventory of oil on hand at the beginning of the month, add oil purchased during the month. The result thus obtained must agree with another figure secured in the following manner
>
> To the total sold during the month, as well as the amount delivered to the company's refinery, add the total ascertained losses during the month (which will include oil used for fuel), and the inventory at the end of the month—after deducting from the latter any carrier oil.

This monthly summary will form the basis for a summarized journal entry for posting to the general ledger. A similar summary should also be prepared every day, and a number of copies made so that the superintendent, sales manager, crude purchase department, general manager and accounting department may each have a copy. This summary should be completed at the latest on the afternoon of the day following that upon which the second gages were taken. If these daily reports are regularly and correctly prepared, they should be of considerable value to the organization as a whole, especially in mapping out operating plans for the future. For example, the crude purchase department will be informed concerning available storage space; the sales manager will be able to see at a glance how much stock he can rely on; and the general superintendent will be enabled to keep close tab on operating losses.

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[1] It may be mentioned in connection with the gaging of inactive tanks, that many tank gagers have a weakness for what are known as *boiler-house gages;* the appellation comes from the fact that the employee, in cold weather, is loath to spend half an hour or more on the top of a tank, so simply remains in the warmth of the boiler house making a guess at the gage based on a previous reading.

CHAPTER XII

CLASSIFICATION OF ACCOUNTS

Since all pipe-line companies engaged in interstate transportation come within the jurisdiction of the Interstate Commerce Commission as common carriers, the arrangement and classification of the accounts of such a company fall within the regulatory powers of that body. In accordance with its authority in this respect the Interstate Commerce Commission has compiled and promulgated a card of accounts, upon the basis of which those companies doing an interstate business are required to keep their records, and to render reports to the commission.[1]

It is to be noted that the classification prescribed by the commission covers three divisions of a pipe-line carrier's accounts; these divisions are:

Investment in pipe lines,
Pipe-line operating revenues, and
Pipe-line operating expenses.

In turn, each of these accounts is divisible as to *Gathering Lines* and *Trunk Lines*. The following quotation from the commission's published classification, distinguishes the two divisions by definition:

> *Gathering lines* are such pipe-line facilities as are used in transporting oil from the wells of producers to points of delivery within the gathering district, or to points of connection with trunk lines for transportation beyond the gathering district, and in such other operations within the district as are incident to the gathering service.
>
> *Trunk lines* are such pipe-line facilities as are used in the transportation of oil which has been gathered from the wells of producers, or has been received from connecting lines, refineries, or vessels.

It should be remarked, in connection with the capital asset accounts, that all charges should be actual money costs to the carrier; trade and cash discounts must be deducted from the gross cost of property acquired. Construction costs will include stationery and printing, taxes, interest, etc., as well as all other expenses accruing during construction.

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[1] Classification of Investment in Pipe Lines, Pipe Line Operating Revenues and Pipe Line Operating Expenses of Carriers by Pipe Lines prescribed by the Interstate Commerce Commission in accordance with Sec. 20 of the Act to Regulate Commerce, Government Printing Office, Washington, D. C.

For the sake of convenience, the card of accounts has been included as part of this chapter, reduced to skeleton form, all explanations being very briefly stated. The fact that the I.C.C. classification, together with notes thereon, has been included as a chapter of the pipe-line section of this volume, should not be interpreted as an intent that the fully detailed classification be dispensed with. The outline and comments here summarized are intended merely to furnish a concisely stated list of the prescribed accounts, and to serve as a memory "jogger." With certain permissible additions, the accounts are those of the commission.

While small companies not engaged in interstate transportation, may be disinclined to keep accounts in such detail as is demanded by the commission's classification, it will be found the wiser procedure to arrange the accounts in such a manner that they can readily be adapted to prescribed accounts whenever the company's operations are extended. Unless this course is followed, it may later be found that the figures obtained on the old basis cannot be readily compared with those prepared on the new.

The following card of accounts contains most of the accounts that should be kept by an average pipe-line company with storage facilities. The account numbers under "G. L. Accts." (Gathering Line Accounts) and "T. L. Accts." (Trunk Line Accounts) are those prescribed by the Interstate Commerce Commission, and the remaining unnumbered accounts have been added in order to make the list complete:

CARD OF ACCOUNTS FOR

Account	G. L. Accts.	T. L. Accts.	Notations of Items to Include
PIPE LINE INVESTMENT			
Land	1	51	Cost of removing structures elsewhere
Rights of way	2	52	Right-of-way damages
Line pipe	3	53	Only pipe 2 inches inside diameter and up
Line-pipe fittings	4	54	Pipe under 2 inches inside diameter
Pipe-line construction	5	55	Labor and teaming, also damages incident to construction
Buildings	6	56	General foundations } Delivery facilities come under 12 or 62
Boilers	7	57	Special foundations
Engines and pumps	8	58	Special foundations
Machine tools and machinery	9	59	Special foundations
Other station equipment	10	60	Boiler attachments; also electric light, gas and refrigeration equipment
Oil tanks	11	61	Grades and fire walls
Delivery facilities	12	62	Delivery racks, docks, etc. Land comes under 1 or 51
Telegraph and telephone lines	13	63	
Office furniture and equipment	14	64	Only movable equipment
Highway equipment	15	65	Horses, harness, autos, wagons, etc.
Other property	16	66	
OPERATING REVENUE			
Actual revenue:			
Transportation revenue	101	151	
Storage and demurrage revenue	102	152	
Miscellaneous revenue	103	153	Revenue from telegrams, telephone messages, and other incidentals
Interdepartmental constructive revenue:			
Transportation service:			
Charges upon the basis of published tariff rates	121/1	171/1	
Charges upon other bases	121/2	171/2	
Storage service:			
Charges upon the basis of published tariff rates	122/1	172/1	
Charges upon other bases	122/2	172/2	
Miscellaneous service	123	173	

A PIPE-LINE COMPANY

Account	G. L. Accts.	T. L. Accts.	Notations of Items to Include
OPERATING EXPENSES			
Maintenance:			
Superintendence	201	251	Salaries of superintendents and assistants, office expenses, etc.
Repairs of pipe lines	202	252	
Changing line construction	203	253	Retirements come under 214 or 264
Repairs of buildings	204	254	
Repairs of pumping stations	205	255	Repairs to equipment only
Repairs of oil tanks	206	256	
Repairs of delivery facilities	207	257	
Repairs of telegraph and telephone lines	208	258	
Repairs of office furniture and equipment	209	259	
Repairs of highway equipment	210	260	
Repairs of other property	211	261	
Other expenses	212	262	
Depreciation	213	263	
Retirements	214	264	Demolishing cost; fire losses come under 238 or 288
Transportation:			
Superintendence	221	271	Salaries of superintendents and assistants, office expenses, etc.
Operation of pipe lines	222	272	
Operation of pumping stations	223	273	
Operation of oil tanks	224	274	
Operation of delivery facilities	225	275	
Operation of telegraph and telephone lines	226	276	
Oil shortage	227	277	Fire losses come under 238 or 288
Other expenses	228	278	
General:			
General office salaries	231	281	Salaries of executives and assistants
General office supplies and expenses.	232	282	Executives' traveling, automobile expense, etc.
Law expenses	233	283	
Injuries to persons	234	284	Law expenses come under 233 or 283
Damage to property	235	285	Oil lost comes under 227 or 277
Stationery and printing	236	286	Postage
Insurance	237	287	
Fire losses	238	288	Credits for insurance recovered
Other expenses	239	289	

(The remaining unnumbered accounts are shown on the next page.)

Sundry Investments

Investments in and advances to affiliated companies
Other securities owned
Sinking fund deposits

Current Assets

Material stores
Crude oil at tank farm
Crude oil at pumping stations
Crude oil in lines
Notes receivable
Accounts receivable, crude oil
Accounts receivable, transportation and storage
Accounts receivable, miscellaneous
Reserve for doubtful accounts (credit)
Due from employees
U. S. Government securities
Cash in banks
Petty cash funds
Oil purchase money in escrow (contra)

Deferred Charges

Unexpired insurance premiums
Prepaid interest
Unamortized expense on capital and bond issues
Miscellaneous prepaid expense
Other unadjusted debits (or credits)

Capital and Liabilities

Capital stock, preferred
Capital stock, common

Bonded indebtedness

Purchase money obligations

Notes payable, banks
Notes payable, others
Due to parent and affiliated companies
Crude oil purchase accounts payable
Vouchers payable
Dividends payable
Wages accrued
Interest accrued
Taxes accrued
Other accrued expenses
Provision for Federal income tax

Oil purchase money in escrow (contra)

Reserve for depreciation
Reserve for contingencies

Capital surplus
Earned surplus
Dividends paid
Profit and loss

CHAPTER XIII

GENERAL ACCOUNTING RECORDS

Just as an untidy yard, with valuable equipment heaped promiscuously in all directions, is the surest mark of a badly operated refinery, so is a slovenly filing system, with a multiplicity of disconnected books and records, an almost infallible indication of a poorly arranged and inefficient accounting system. Before its final approval for installation, every proposed record or form should be subjected to a series of test questions, somewhat as follows:

Is any of the information called for being recorded elsewhere?

Will the information afforded be of genuine value?

Will the cost of securing the information be greater than it is worth?

If, after these questions have been considered, it still appears that the record is needed, steps to install it should be taken; the dimensions of the record, however, should have very serious consideration, since unwieldy records are always a source of considerable annoyance.[1]

It is a good plan for one individual in an organization, who has detailed knowledge of the system in use, to have the final authority to pass records for the printer. This does not mean that this particular individual should design all forms, but he should at any rate be consulted before the final form is approved. In most organizations where a number of records which record similar information are in use, the existing condition is the result of lack of cooperation between departments; in many cases a duplicate record might have been avoided if an extra carbon copy of a particular form had been provided, for the use of another department.[2]

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[1] Records of the standard size 11 by 17 inches are found very convenient in practice; the reader is referred to the discussion of this size of record in Chap. IX.

[2] It is a noteworthy fact that purchases and sales departments are loath to consider their records as in any way connected with those of the accounting department. As an example, take the purchase order, which may be

The records which are required to keep the accounts of a pipe-line transporting company will usually be somewhat as follows:

General ledger.
Journal voucher.
Summary of oil receipts and deliveries, Form 11 (page 130).
Crude purchase journal, Form 12 (page 132).
Register of carrier oil, Form 13 (page 133).
Tank farm daily report, Form 14 (page 134).
Crude sales journal, Form 15 (page 135).
Voucher record, Form 16 (page 136).
Cash voucher, Form 17 (page 137).
Cash receipts, Form 18 (page 138).
Cash disbursements, Form 19 (page 139).
Gage ticket, Form 20 (page 140).

General Ledger.—The objections which may be raised to the use of a bound book for a general ledger are, perhaps, not so warranted in the case of a pipe-line company as in that of a producing company. The principal objection, in both cases, is the difficulty of accurately estimating the relative number of ledger pages which should be allocated to the respective accounts. However, a bound general ledger has so very few advantages and is open to so many objections, that its use is not recommended in any division of the petroleum industry.

As in the case of a producing company, a substantial loose-leaf book should be used; where sub-accounts are desired, different colored sheets may be inserted following the main account. The journal style of ledger sheet will be found particularly serviceable, since it has the advantage of stating an account in narrative form.

Journal Voucher.—It is suggested that the journal voucher supplant the general journal. It should be the same size as the cash voucher (Form 17), but of a different color.

To obviate the possible mislaying of journal vouchers, it is recommended that they be prepared in duplicate, the original, with supporting papers attached, being placed in the files, while the duplicate is filed in a permanent post binder.

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designed to serve a number of purposes; in many companies this form is prepared by the purchasing department for the use of the purchasing department only, and the receiving, stores, and accounting departments are not provided for.

A series of numbers differing from those used for cash vouchers should be adopted, the number being preceded by the letter "J" to denote journal voucher.

Summary of Oil Receipts and Deliveries.—This form has been discussed at length in Chap. XI, and requires no further comment here. It may be mentioned that the record should be kept in a separate binder, forming, as it does, a type of operating record quite distinct from the ordinary books of account. Where the size of the organization warrants, a separate oil-movements department might well be installed.

Crude Purchase Journal.—It is intended that this sheet be used to record all oil purchased by the company. It will be noted that provision has been made for the extension of the amount of each purchase. Practice in this respect differs among pipe-line companies, especially as regards the method of posting to the detail crude oil purchase accounts payable ledgers.

Under one method, used by several of the smaller companies, each entry in the crude purchase journal is extended in money, and is posted to a ledger sheet headed with the name of the lease from which the oil was taken. These sheets are usually arranged by states, counties, and leases, each sheet showing at the top the fractional division owned by each party having a share interest. At the end of the month, the total barrels run, together with the total amount credited therefor, is divided according to the division order, and statements are mailed to the various parties. This method of handling purchases has the advantage of making instantly available the total cost of oil purchased during any day or period, but is open to the objection that it entails considerably more accounting work than the second, and probably preferable, method.

In the second method, extension of amounts is not made in the crude purchase journal, and the ledger accounts of the various leases are only credited with *barrels* run. Every 15 days the total barrels credited are divided according to the division order, and the amounts thereof extended.

Most of the larger pipe-line companies now use mechanical posting machines on their crude payable ledgers. As each account is posted, day by day, statements to the number of the divisional interests in the production are built up. On the fifteenth and last days of the month, or as soon thereafter as all posting is completed, the various statements are rubber stamped somewhat as follows:

Total oil run .... barrels
Your .... interest .... barrels
.... barrels @ $...... $..........
.... barrels @ $...... $..........
$..........

and are mailed out. The statements sent at the close of the month are accompanied by checks.

The crude purchase journal, in addition to forming a posting medium for the crude purchase accounts payable ledgers, also provides a basis for daily entry to the summary of oil receipts and deliveries.

Register of Carrier Oil.—This form has been designed to keep exact account of all oil or products accepted for transportation from one point to another, or for temporary storage; it will also provide a basis for charge at published tariff rates to the various companies to which the service is rendered.

The gage tickets (designated as to carrier oil) will be entered in the record in detail, care being taken that no information for which the form provides is omitted. As the oil is delivered, or reaches the tank farm for storage, report thereof should be received by the accounting department. It will be noted that all open items in the *Oil received* section of the form will represent carrier oil in the company's gathering and trunk lines, while any open items in the *Stored at tank farm* section will constitute bailment oil held in storage.

Since the record is not controlled by the general ledger, precautionary measures should be taken that the employee entrusted with its keeping be impressed with the fact that it is not a mere memorandum record, to be kept in a careless, slovenly manner. The information furnished is as vital to the company as that furnished by any of the other operating records, and it is to be remembered that an error in the register of carrier oil will have the effect of throwing the summary of receipts and deliveries out of balance for the day.

Tank Farm Daily Report.—This record was discussed in detail in Chap. XI. It should be prepared in duplicate at the tank farm office, one copy being retained there and the other forwarded to the accounting department. This form, as well as all the other oil movement reports, should be punched to fit a post binder; it should be carefully filed chronologically by stations.

Crude Sales Journal.—The crude sales journal will be entered from the "S" series of gage tickets, and should include all sales made, either to outsiders or to the company's own refinery. Posting to the accounts receivable ledgers will be made direct from this record.

Voucher Record.—In preparing this form, the necessity for following out the I.C.C. classification of accounts has been kept in mind. On account of the detailed subdivision made in the classification, it has been practicable to provide for three main divisions only: Gathering Line accounts, Trunk Line accounts, and any other accounts not included in the classification; the first two of these have been further subdivided as to investment and expense. It is believed that the form requires no further explanation.

At the end of each month the I.C.C. classification columns must be analyzed by accounts, and the summary entered in the voucher record. This can be done either on an analysis sheet, which can then be attached to the journal entry summarizing the voucher record totals, or in a more permanent record in bound or loose-leaf form.

Cash Voucher.—The cash voucher has been designed in such a manner that it will dovetail with the other accounting records necessary under the I.C.C. classification of accounts. These vouchers should be numbered consecutively, the same system of designating month and year being employed as was explained for the producing company cash voucher. It is always better to file vouchers flat, without folding; in the few cases where a great many supporting papers are attached, a cardboard back may be affixed to the voucher to protect against tearing.

If found more convenient, the analysis of vouchers for the month may be made direct from the vouchers themselves rather than from the voucher record; it will be found that the arrangement of accounts on the voucher will facilitate this method.

Cash Receipts.—The larger proportion of a pipe-line company's cash collections will be those arising from accounts receivable for services rendered, or from oil sold. Provision has been made in the accounts to keep these various classes of receivables separate; where the company delivers oil to an intercompany refinery, there will probably be very little oil sold to outsiders. For this reason no difficulty in keeping affiliated receivables separate from those due from outsiders will be encountered, and it has been thought sufficient to provide only one column for crude oil accounts receivable in the cash receipts record.

In accordance with approved accounting procedure, all cash received should be deposited in the bank intact, and the daily bank deposits shown by the cash book should always be in agreement with those shown by the bank pass book.

Cash Disbursements.—It is believed that this record is sufficiently self-explanatory and will require little comment. It will be remarked that no column is provided for cash discounts. All discounts should be deducted from invoices at the time the voucher is prepared, only net amounts being entered in the accounts. This is in accordance with accounting practice prescribed by the Interstate Commerce Commission, as well as with conservative accounting procedure.

Gage Ticket.—This form has been explained in detail in Chap. XI. Many companies have their gage tickets printed with carboned reverse sides, but tickets of this kind are objectionable for a number of reasons. They have little advantage over a ticket prepared with an ordinary piece of carbon paper, and are usually much less legible; and they do not form a good permanent record.

If the gage tickets are made up in book form, the original copy (colored) for remittance to the office being perforated, the carbon copy (white) can be bound into the book and will not then be mislaid.

Payrolls.—A payroll sheet, designed along the same general lines as production department Form 7 (page 90), should be used for recording the company's payroll. The exact amount of each payroll should be transferred to a separate bank account, and the individual checks drawn thereagainst. As in the case of the production department, time and labor reports should be rendered by a foreman in charge, or else by a timekeeper. Systems which require the workmen to prepare their own reports are not practicable in most cases.

In order to provide a reasonable safeguard against payroll padding, each payroll should be approved by the superintendent; periodically a representative of the accounting department should pass out the pay checks.

The labor costs will fall naturally into three main divisions:

Construction.
Gathering line operation and maintenance.
Trunk line operation and maintenance.

Labor chargeable to construction should be passed through the authorization record (see below), and thence will be closed out to appropriate accounts. Labor in connection with the operation and maintenance of the company's lines should be classified in accordance with the I.C.C. card of accounts.

The periodic payroll should be summarized on a journal voucher; it will be well, however, to file the pay sheets in a binder, so that the canceled checks may be marked off when they are returned by the bank.

Service Departments.—Whenever the company's operations make necessary the maintenance of special service departments as, for example, boiler plants, electric plants, oil-treating plants and the like, separate accounts may be opened. At the close of each period, the expenses accumulated in these accounts will be cleared out to departments benefiting, on the basis of service rendered.

Authorizations.—In order to exercise proper control over expenditures for construction work or for extraordinary maintenance, it is advisable that a system of authorizations for expenditure be inaugurated. The same general accounting principles are applicable in the case of pipe-line companies as were explained for oil producing companies; for this reason mechanical procedure will not be repeated here.

A construction in progress record should be kept of all new work in process, arranged according to capital asset classifications, but it must be closed out monthly to the various asset accounts in order to conform with I.C.C. regulations. The totals for each authorization can, however, be carried forward in the construction in progress record and a subsidiary control kept of all uncompleted authorizations in some such form as the following:

Uncompleted authorizations at beginning of month............	$........
Expenditures during month (per general books)...............	....
Together..	$........
Deduct—Authorizations closed during the month...............	....
Uncompleted authorizations at end of month..................	$........

If open authorizations are numerous it will be well to carry the above summary in columnar form allowing a separate line for each authorization. On this summary might also be shown the original amount authorized together with the balance unexpended at date, so that the management may be kept advised thereon month by month.

Depreciation.—The following rates of depreciation are suggested for pipe-line companies by the *Manual for the Oil and Gas Industry;*[1] these rates are to be applied on the straight-line basis, all depreciation on dismantled or scrapped assets not provided for, being charged to one of the retirement accounts:

Class of Equipment	Suggested Annual Rate, Per Cent
Mains 6 inches in diameter or over	5
Mains under 6 inches in diameter	6¼
Gathering lines	10
Pump stations, including all equipment, telephone lines and terminal facilities	10
Dehydrators, electric	20
Dehydrators, pipe or tank type	50
Storage tanks:	
Steel—2,500 to 5,000 barrels	8⅓
Steel—5,000 to 55,000 barrels	5
Galvanized iron—Up to 500 barrels	12½
Galvanized iron—500 to 2,500 barrels	8⅓
Wood	20
Movable, G. I.—Up to 500 barrels	16⅔
Movable, G. I.—500 to 2,500 barrels	11⅑
Water, G. I. movable—Up to 500 barrels	20
Water, G. I. movable—500 to 2,500 barrels	12½

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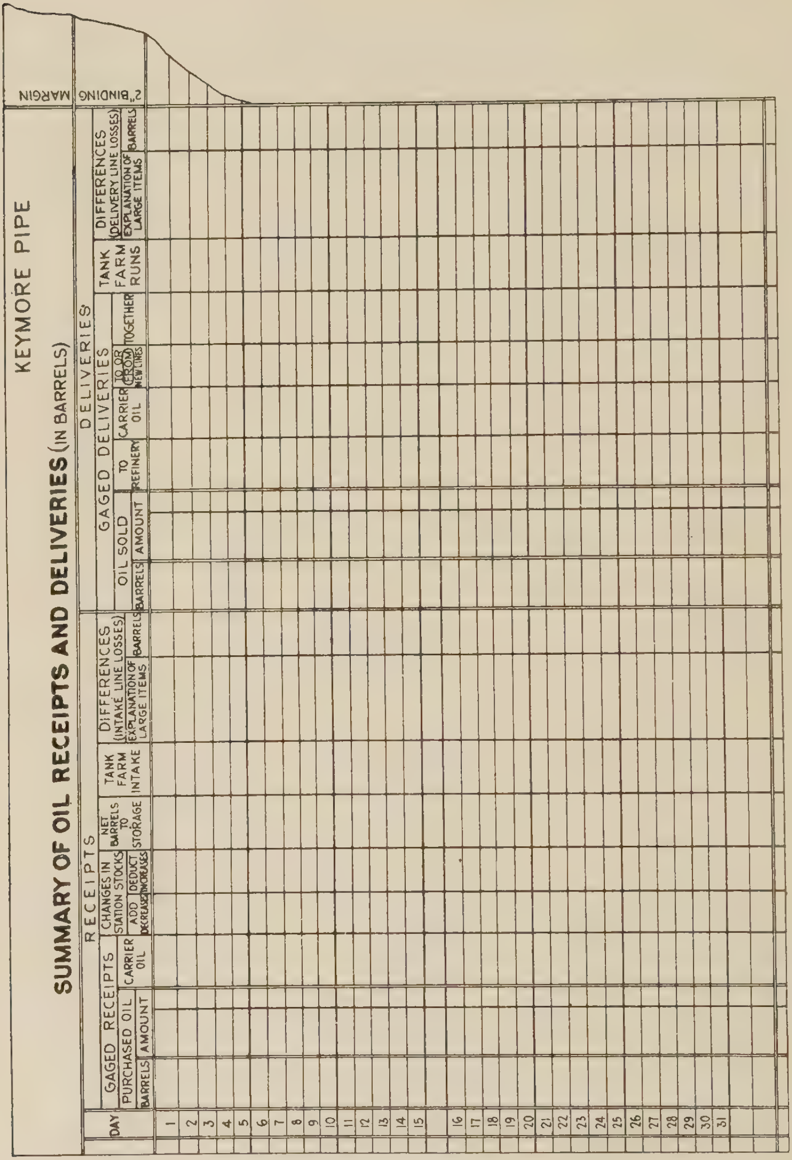
[1] "The percentages are neither maximum nor minimum rates. They are not to be applied indiscriminately to specific property, and the Internal Revenue Bureau is in no way committed to accept allowances based upon them." Quoted from the *Manual for the Oil and Gas Industry.*

Suggested forms of records for a pipe-line company are shown on pages 130 to 140.



MARGIN

2" BINDING

KEYMORE PIPE

SUMMARY OF OIL RECEIPTS AND DELIVERIES (IN BARRELS)

	RECEIPTS									DELIVERIES								
	GAGED RECEIPTS			CHANGES IN STATION STOCKS		NET BARRELS TO STORAGE	TANK FARM INTAKE	DIFFERENCES (INTAKE LINE LOSSES)		GAGED DELIVERIES						TANK FARM RUNS	DIFFERENCES (DELIVERY LINE LOSSES)	
	PURCHASED OIL		CARRIER OIL	ADD	DEDUCT					OIL SOLD		TO REFINERY	CARRIER OIL	TO OR FROM NEW LINES	TOGETHER			
DAY	BARRELS	AMOUNT		DECREASES	INCREASES			EXPLANATION OF LARGE ITEMS	BARRELS	BARRELS	AMOUNT						EXPLANATION OF LARGE ITEMS	BARRELS
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
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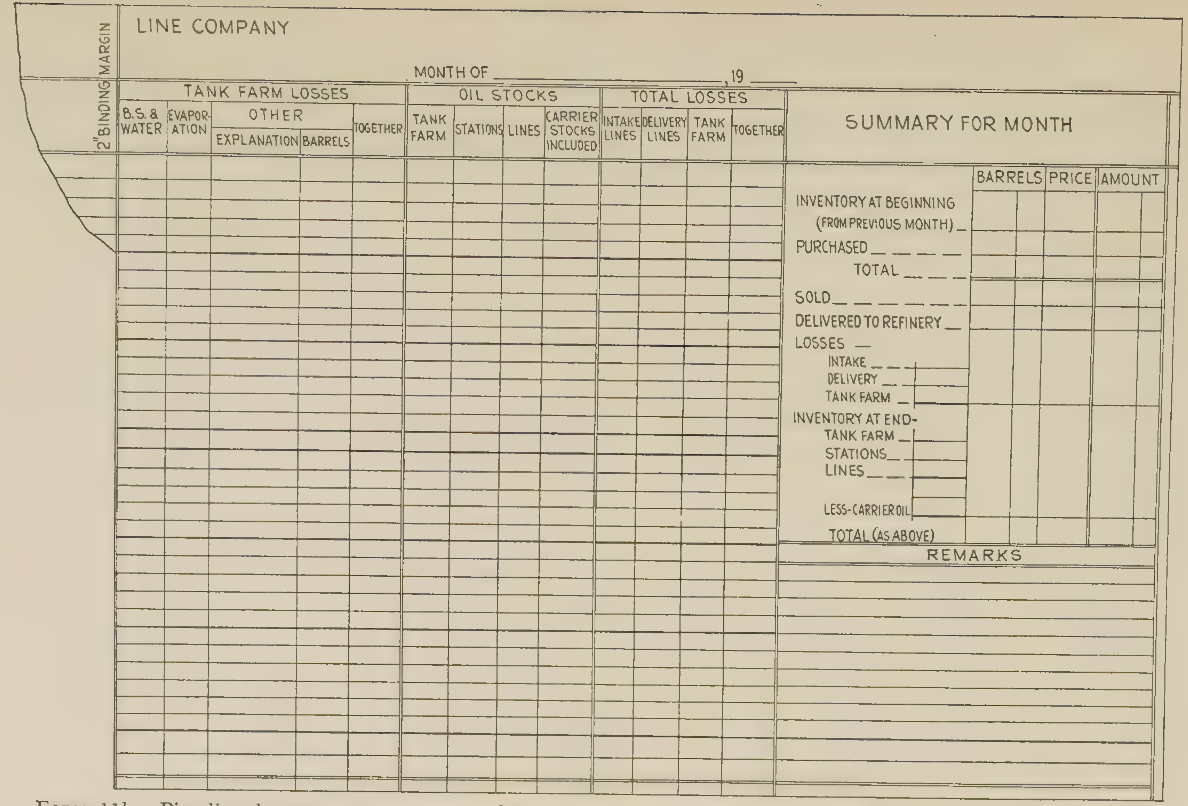
FORM 11*a*.—Pipe line department—summary of oil receipts and deliveries (left page). (17 × 11 in. Loose leaf.)



2" BINDING MARGIN

LINE COMPANY

MONTH OF ____________, 19 ____

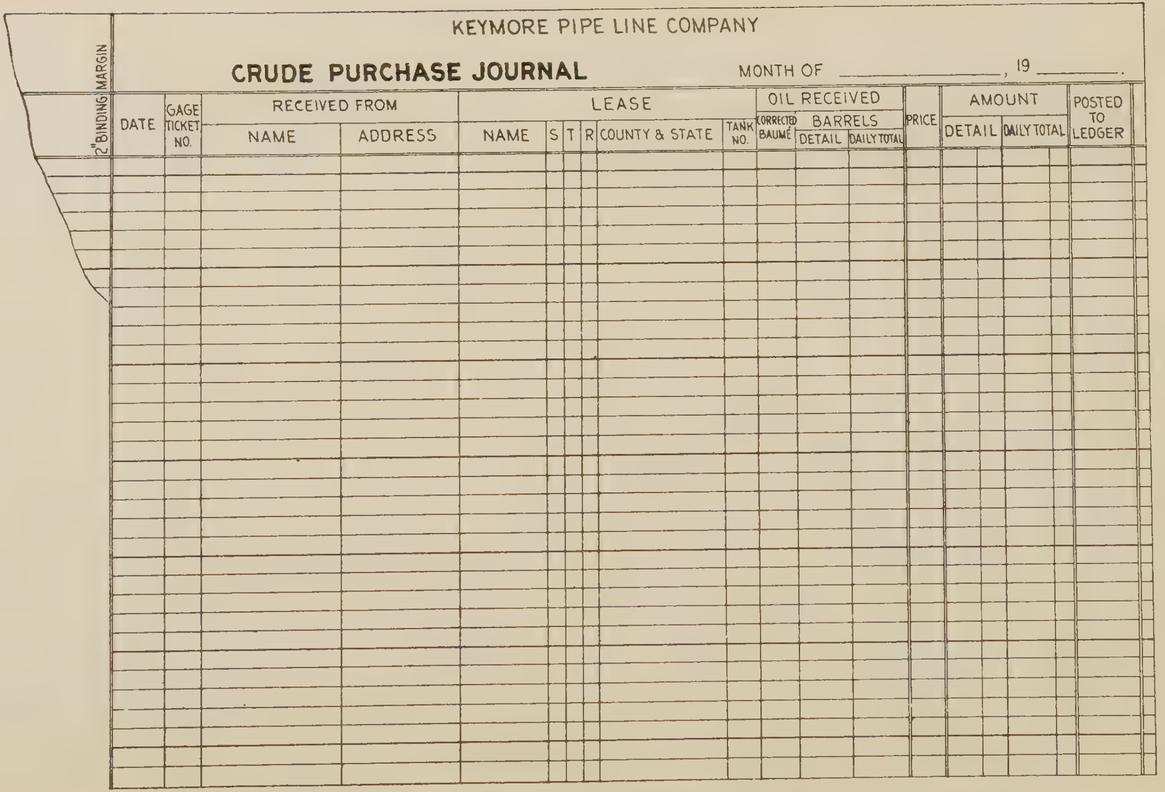
TANK FARM LOSSES					OIL STOCKS				TOTAL LOSSES			
B.S. & WATER	EVAPORATION	OTHER		TOGETHER	TANK FARM	STATIONS	LINES	CARRIER STOCKS INCLUDED	INTAKE LINES	DELIVERY LINES	TANK FARM	TOGETHER
		EXPLANATION	BARRELS									

SUMMARY FOR MONTH

	BARRELS	PRICE	AMOUNT
INVENTORY AT BEGINNING (FROM PREVIOUS MONTH) ___			
PURCHASED ___			
TOTAL ___			
SOLD ___			
DELIVERED TO REFINERY ___			
LOSSES —			
INTAKE ___			
DELIVERY ___			
TANK FARM ___			
INVENTORY AT END-			
TANK FARM ___			
STATIONS ___			
LINES ___			
LESS-CARRIER OIL			
TOTAL (AS ABOVE)			

REMARKS

Form 11*b*.—Pipe line department—summary of oil receipts and deliveries (right page). (17 × 11 in. Loose leaf.)



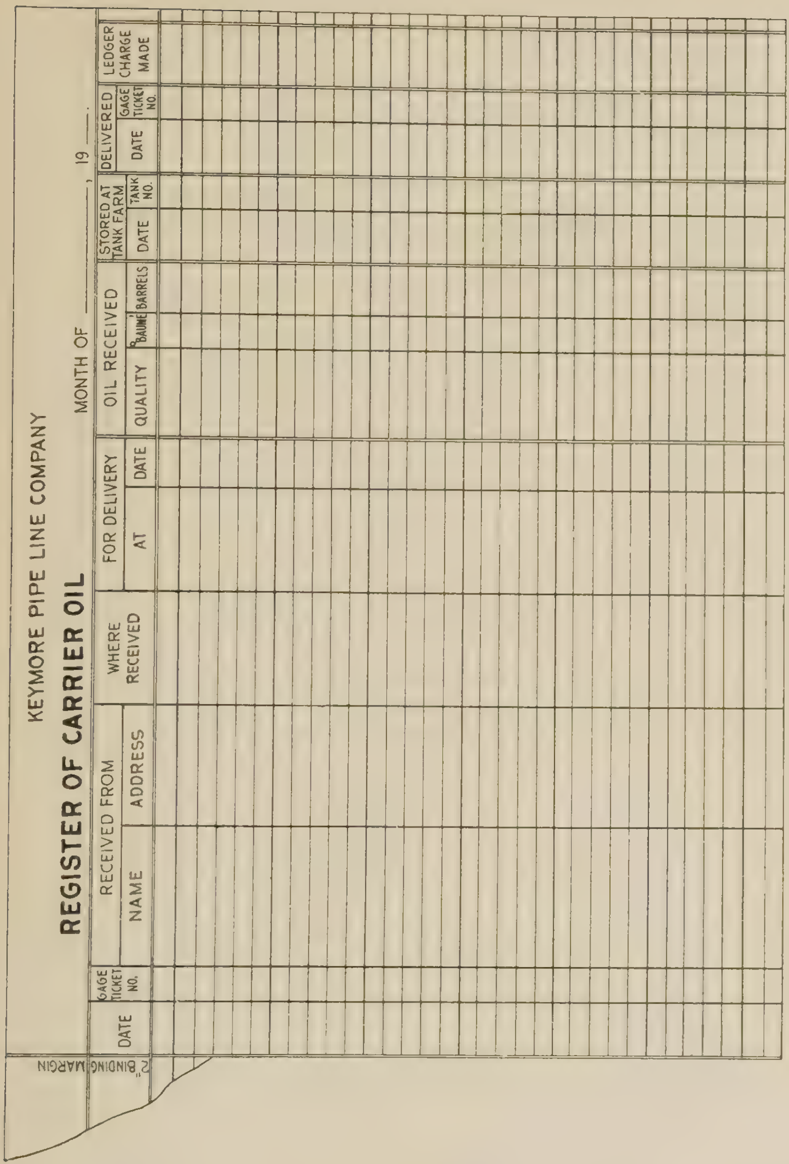
2" BINDING MARGIN

KEYMORE PIPE LINE COMPANY

CRUDE PURCHASE JOURNAL MONTH OF ______________, 19 ________.

DATE	GAGE TICKET NO.	RECEIVED FROM		LEASE						OIL RECEIVED			PRICE	AMOUNT		POSTED TO LEDGER
										CORRECTED BAUMÉ	BARRELS					
		NAME	ADDRESS	NAME	S	T	R	COUNTY & STATE	TANK NO.		DETAIL	DAILY TOTAL		DETAIL	DAILY TOTAL	

Form 12.—Pipe line department—crude purchase journal. (17 × 11 in. Loose leaf.)



KEYMORE PIPE LINE COMPANY

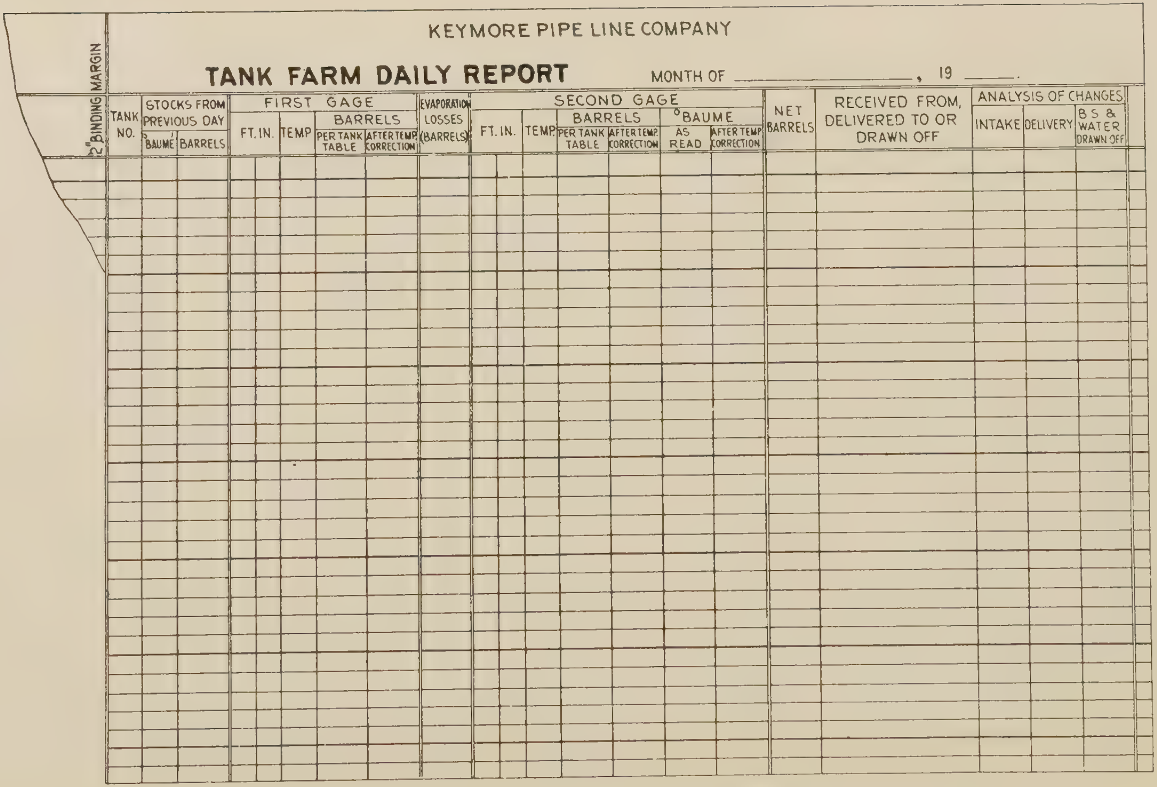
REGISTER OF CARRIER OIL

MONTH OF ________, 19___.

DATE	GAGE TICKET NO.	RECEIVED FROM		WHERE RECEIVED	FOR DELIVERY		OIL RECEIVED			STORED AT TANK FARM		DELIVERED		LEDGER CHARGE MADE
		NAME	ADDRESS		AT	DATE	QUALITY	°BAUMÉ	BARRELS	DATE	TANK NO.	DATE	GAGE TICKET NO.	

2" BINDING MARGIN

FORM 13.—Pipe line department—register of carrier oil. (17 × 11 in. Loose leaf.)



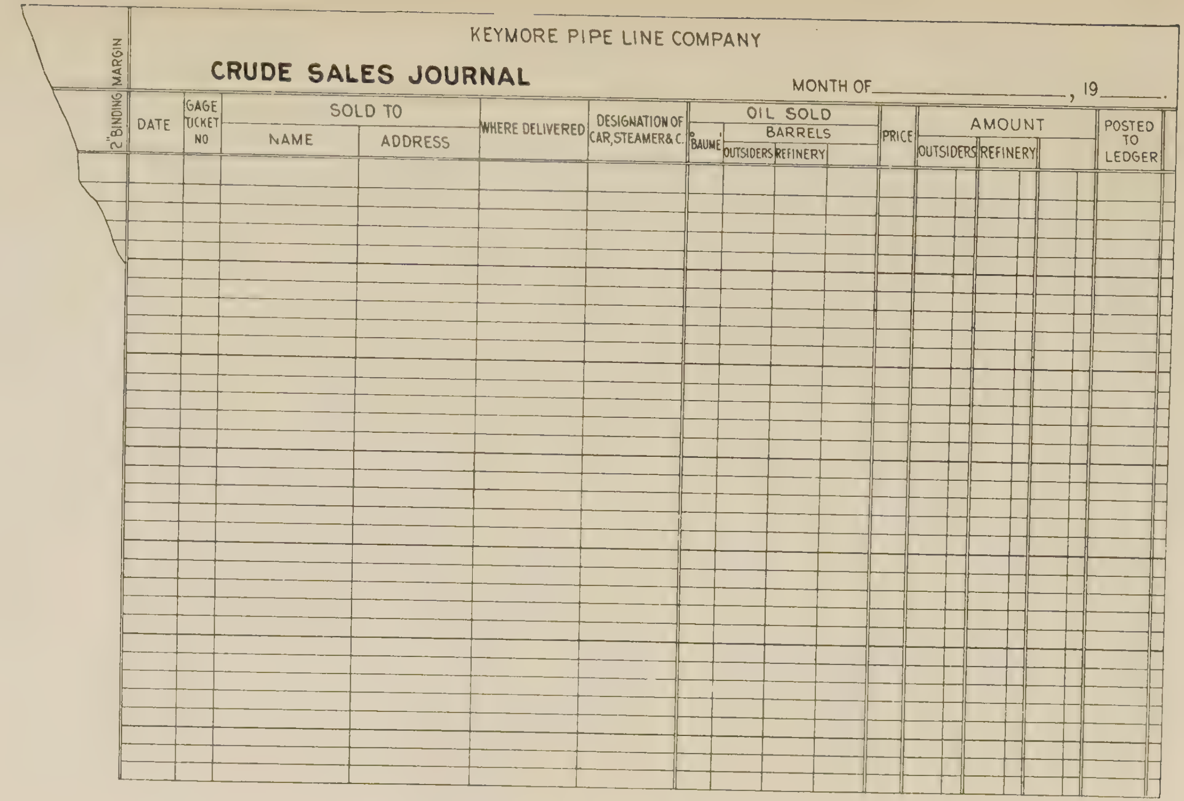
½" BINDING MARGIN

KEYMORE PIPE LINE COMPANY

TANK FARM DAILY REPORT MONTH OF ______________, 19 ____.

TANK NO.	STOCKS FROM PREVIOUS DAY		FIRST GAGE				EVAPORATION LOSSES (BARRELS)	SECOND GAGE						NET BARRELS	RECEIVED FROM, DELIVERED TO OR DRAWN OFF	ANALYSIS OF CHANGES		
					BARRELS					BARRELS		°BAUME						
	°BAUME	BARRELS	FT. IN.	TEMP	PER TANK TABLE	AFTER TEMP CORRECTION		FT. IN.	TEMP	PER TANK TABLE	AFTER TEMP. CORRECTION	AS READ	AFTER TEMP CORRECTION			INTAKE	DELIVERY	B S & WATER DRAWN OFF

Form 14.—Pipe line department—tank farm daily report. (17 × 11 in. Loose leaf.)



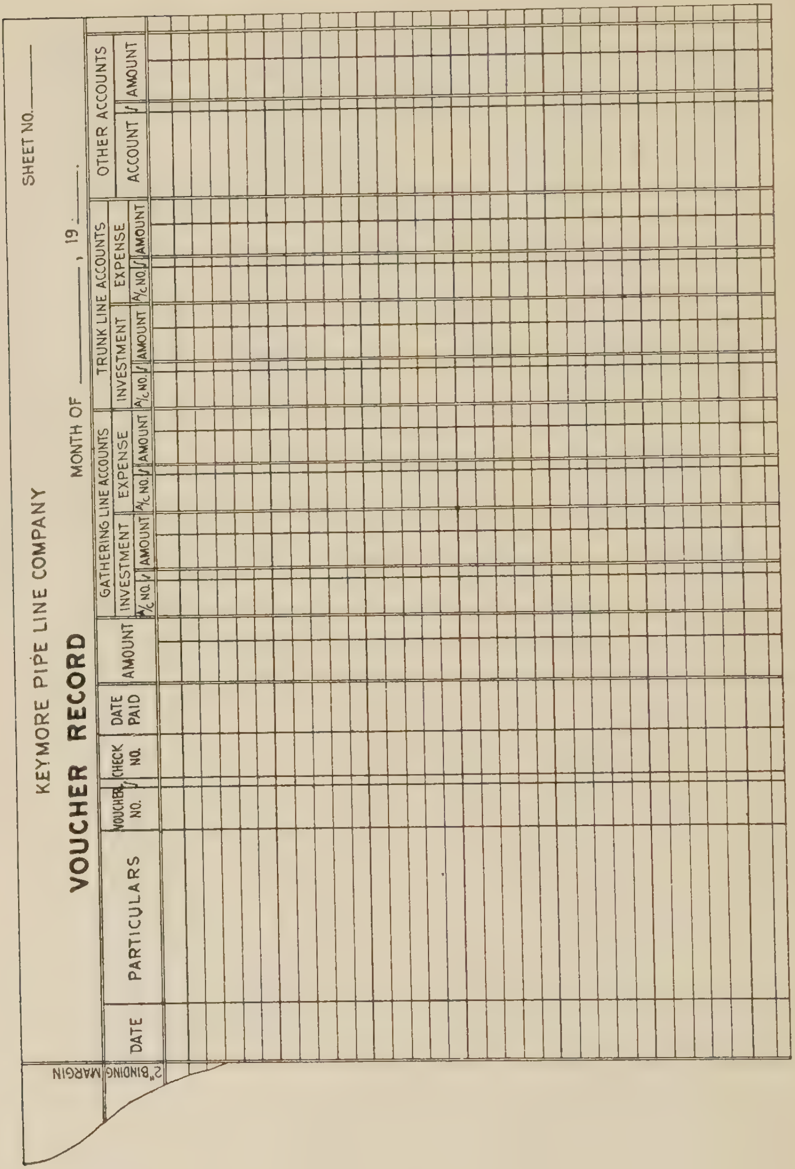
KEYMORE PIPE LINE COMPANY

CRUDE SALES JOURNAL

MONTH OF __________, 19____.

2" BINDING MARGIN	DATE	GAGE TICKET NO	SOLD TO		WHERE DELIVERED	DESIGNATION OF CAR, STEAMER & C.	OIL SOLD				PRICE	AMOUNT			POSTED TO LEDGER
			NAME	ADDRESS			°BAUMÉ	BARRELS							
								OUTSIDERS	REFINERY			OUTSIDERS	REFINERY		

Form 15.—Pipe line department—crude sales journal. (17 × 11 in. Loose leaf.)



KEYMORE PIPE LINE COMPANY

SHEET NO.____

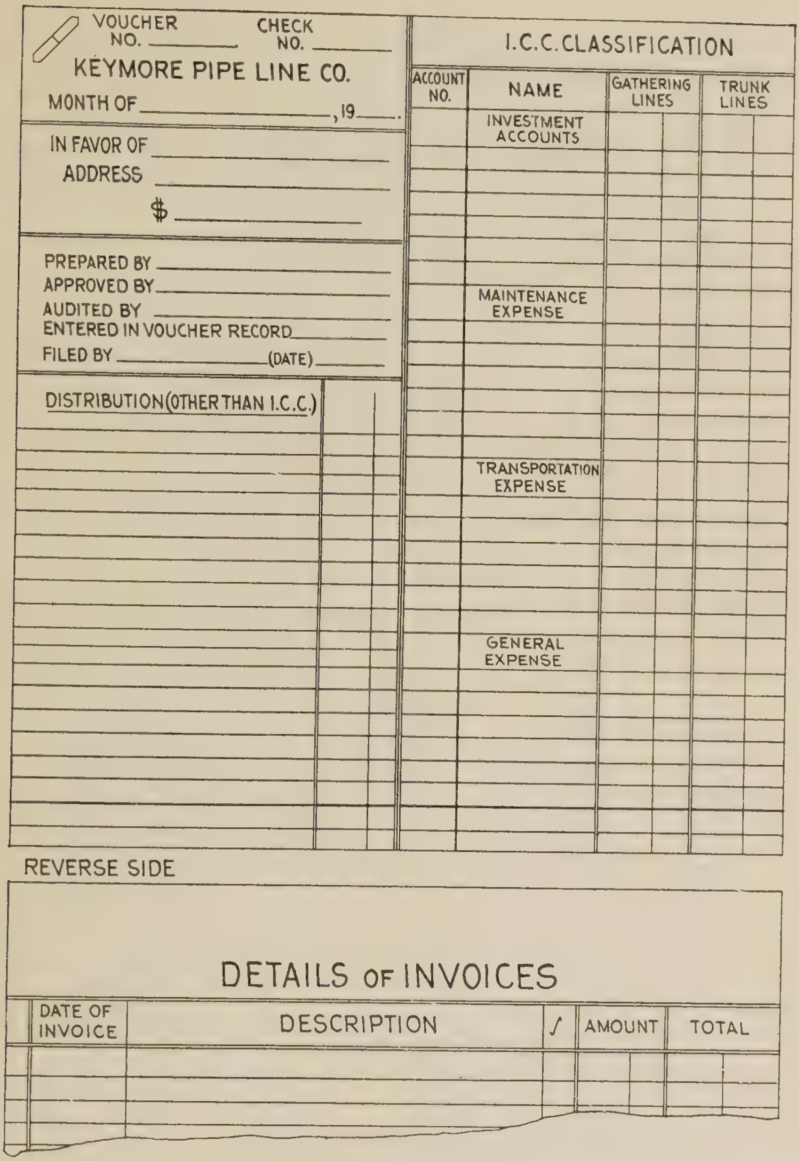
VOUCHER RECORD

MONTH OF ________, 19__.

2" BINDING MARGIN

DATE	PARTICULARS	VOUCHER NO.	✓	CHECK NO.	DATE PAID	AMOUNT	GATHERING LINE ACCOUNTS						TRUNK LINE ACCOUNTS						OTHER ACCOUNTS		
							INVESTMENT			EXPENSE			INVESTMENT			EXPENSE					
							A/C NO.	✓	AMOUNT	A/C NO.	✓	AMOUNT	A/C NO.	✓	AMOUNT	A/C NO.	✓	AMOUNT	ACCOUNT	✓	AMOUNT

FORM 16.—Pipe line department—voucher record. (17 × 11 in. Loose leaf.)



VOUCHER NO. ________ CHECK NO. ________

KEYMORE PIPE LINE CO.

MONTH OF ________________, 19____.

IN FAVOR OF ________________

ADDRESS ________________

$ ________________

PREPARED BY ________________

APPROVED BY ________________

AUDITED BY ________________

ENTERED IN VOUCHER RECORD ________________

FILED BY ____________ (DATE) ________

DISTRIBUTION (OTHER THAN I.C.C.)

I.C.C. CLASSIFICATION

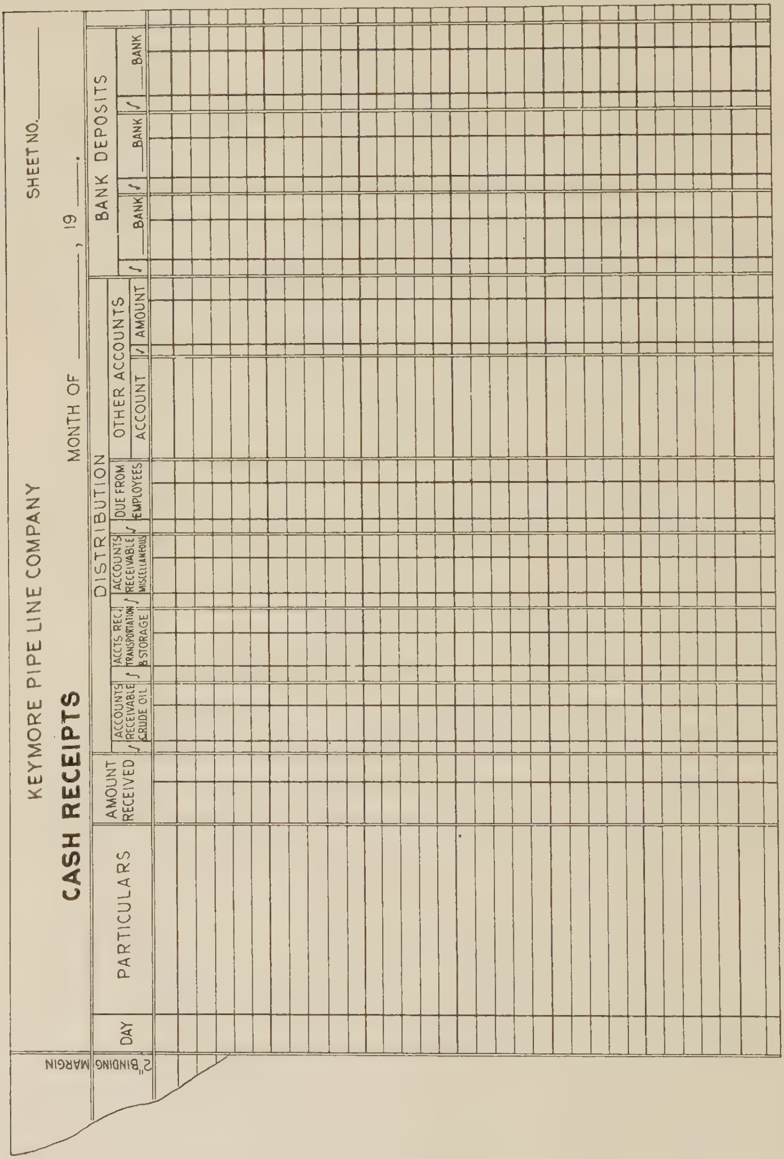
ACCOUNT NO.	NAME	GATHERING LINES		TRUNK LINES	
	INVESTMENT ACCOUNTS				
	MAINTENANCE EXPENSE				
	TRANSPORTATION EXPENSE				
	GENERAL EXPENSE				

REVERSE SIDE

DETAILS OF INVOICES

	DATE OF INVOICE	DESCRIPTION	✓	AMOUNT		TOTAL	

Form 17.—Pipe line department—cash voucher. (8½ × 9¼ in.)



KEYMORE PIPE LINE COMPANY

SHEET NO.____

CASH RECEIPTS

MONTH OF ________, 19___.

2" BINDING MARGIN	DAY	PARTICULARS	AMOUNT RECEIVED	DISTRIBUTION						BANK DEPOSITS		
				✓ ACCOUNTS RECEIVABLE CRUDE OIL	✓ ACCTS. REC'L TRANSPORTATION & STORAGE	✓ ACCOUNTS RECEIVABLE MISCELLANEOUS	✓ DUE FROM EMPLOYEES	OTHER ACCOUNTS		✓ ____BANK	✓ ____BANK	✓ ____BANK
								ACCOUNT	✓ AMOUNT			

Form 18.—Pipe line department—cash receipts. (17 × 11 in. Loose leaf.)

KEYMORE PIPE LINE COMPANY

____________ BANK

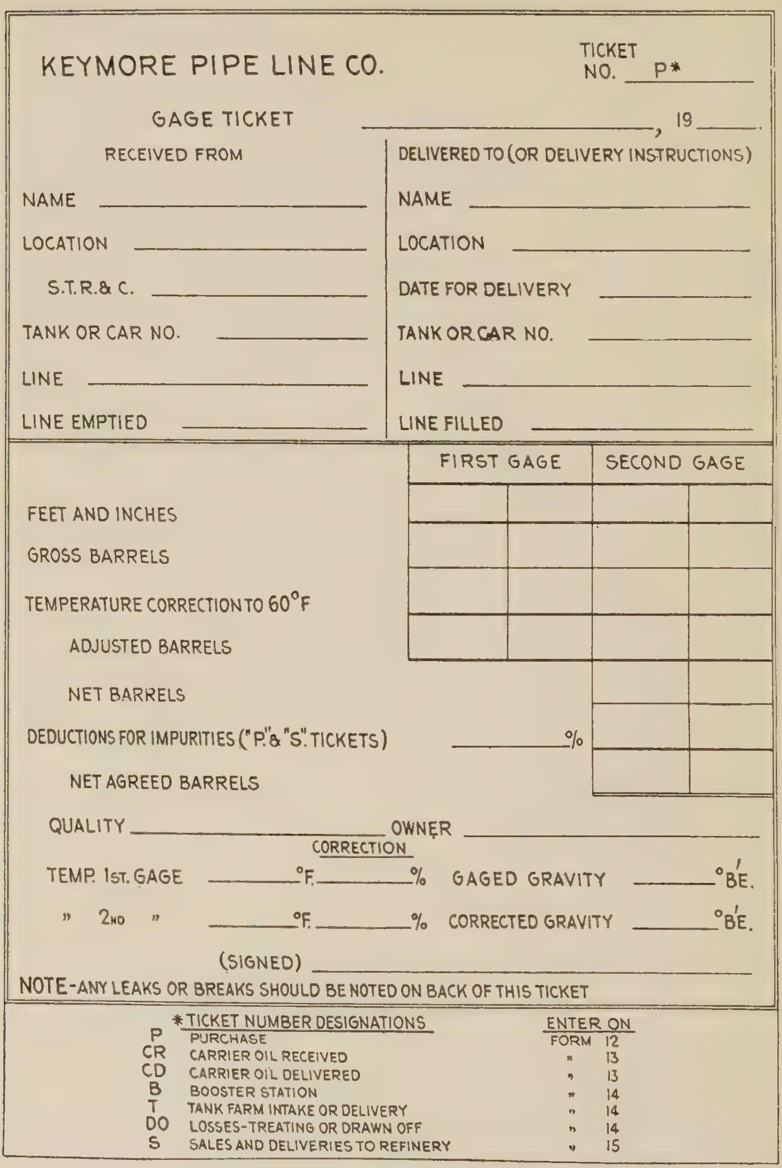
SHEET NO. ________

CASH DISBURSEMENTS

MONTH OF __________, 19 ___.

2" BINDING MARGIN	DAY	PARTICULARS	CHECKS DRAWN			VOUCHER NUMBER	DISTRIBUTION									MEMO. OF BANK BALANCE			
			NUMBER	✓	AMOUNT		✓	CRUDE OIL ACCOUNTS PAYABLE	✓	VOUCHERS PAYABLE	✓	DIVIDENDS PAYABLE	OTHER ACCOUNTS ACCOUNT	✓	OTHER ACCOUNTS AMOUNT	TOTAL CHECKS	DEPOSITS (FROM CASH RECEIPTS)	✓	DAILY BALANCE

FORM 19.—Pipe line department—cash disbursements. (17 × 11 in. Loose leaf.)



KEYMORE PIPE LINE CO.

TICKET NO. P*

GAGE TICKET ____________, 19____

RECEIVED FROM		DELIVERED TO (OR DELIVERY INSTRUCTIONS)	
NAME	____________	NAME	____________
LOCATION	____________	LOCATION	____________
S.T.R.& C.	____________	DATE FOR DELIVERY	____________
TANK OR CAR NO.	____________	TANK OR CAR NO.	____________
LINE	____________	LINE	____________
LINE EMPTIED	____________	LINE FILLED	____________

	FIRST GAGE		SECOND GAGE	
FEET AND INCHES				
GROSS BARRELS				
TEMPERATURE CORRECTION TO 60°F				
ADJUSTED BARRELS				
NET BARRELS				
DEDUCTIONS FOR IMPURITIES ("P." & "S." TICKETS)	________%			
NET AGREED BARRELS				

QUALITY ____________ OWNER ____________

		CORRECTION		
TEMP. 1ST. GAGE	______°F.	______%	GAGED GRAVITY	______°BÉ.
" 2ND "	______°F.	______%	CORRECTED GRAVITY	______°BÉ.

(SIGNED) ____________

NOTE—ANY LEAKS OR BREAKS SHOULD BE NOTED ON BACK OF THIS TICKET

	*TICKET NUMBER DESIGNATIONS	ENTER ON	
P	PURCHASE	FORM	12
CR	CARRIER OIL RECEIVED	"	13
CD	CARRIER OIL DELIVERED	"	13
B	BOOSTER STATION	"	14
T	TANK FARM INTAKE OR DELIVERY	"	14
DO	LOSSES-TREATING OR DRAWN OFF	"	14
S	SALES AND DELIVERIES TO REFINERY	"	15

FORM 20.—Pipe line department—gage ticket. (4¼ × 5½ in.)

PART III

REFINING

CHAPTER XIV

REFINERY PRACTICE

Although we find that man has made some use of petroleum in its crude state for the past 2,000 years, it has remained to the nineteenth and twentieth centuries to devise means for extracting the various constituent elements from petroleum, and to find new applications and uses for the products.

There are between 1,100 and 1,200 casinghead gasoline plants in the United States, and about 600 crude-oil refineries; the total daily capacity of the latter is approximately 3,000,000 barrels. The fact that there are more than 15,000,000 automobiles registered in the United States (Mr. Ford has recently manufactured his *ten-millionth* car!) when considered in conjunction with the enormity of America's exports of petroleum products, soon brings one to realize the full importance of the business of refining petroleum.

The following is a summary of refinery operations and production in the United States during the year 1923:[1]

	Total for Year	Daily Average
Oils run to stills (in barrels of 42 U. S. gallons each):		
Domestic crude petroleum	538,252,291	1,474,664
Foreign crude petroleum	42,985,525	117,769
Unfinished domestic oils	12,344,612	33,821
Unfinished oils	5,775,852	15,824
Casinghead gasoline	5,487,007	15,033
Total barrels	604,845,287	1,657,111
Refinery production:		
Gasoline, gallons	7,555,945,143	20,701,220
Kerosene, gallons	2,348,934,712	6,435,438
Gas oil and fuel oil, gallons	12,074,191,693	33,079,977
Lubricants, gallons	1,097,368,222	3,006,488
Wax, pounds	466,646,551	1,278,484
Coke, tons	672,526	1,843
Asphalt, tons	2,327,116	6,376
Other products, gallons	213,626,207	585,277
Unfinished products, gallons	550,622,434	1,508,555

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[1] Compiled from figures published in the *Oil and Gas Journal*.

Refineries may be classified into three groups, as follows:

1. Complete refineries producing naphthas, gasolines, kerosene, gas oil, straw oil, fuel oil, lubricating oils, greases, petrolatum, paraffin wax, coke and asphalt.
2. Skimming, topping, lubricating, compounding, wax, coke and asphalt plants. The products of any one of this group will depend upon the operating policy of the company, and any of the products under the first group may be produced.
3. Natural, or casinghead, gasoline plants which produce natural (casinghead) gasoline.

Complete Refineries.—Although complete refineries may be broadly classified as to those employing the *batch method* of distillation and those in which the *continuous method* is used, refining procedure varies according to the type of crude oil available to the refinery, as well as according to the technical experience and product objectives of the management. As a matter of fact, it is a rare occurrence to find two plants which follow precisely the same plan of refining.

Type of Petroleum Available.—The first concern of the refiner is the kind of crude petroleum which he is likely to procure. Petroleum falls into the major classifications of:

Paraffin base oil,
Asphalt base oil, and
Mixed base oil.[1]

From the first of these there is usually recovered a relatively large percentage of gasoline, as well as stock for the manufacture of lubricating oils; as these are the most valuable of petroleum derivatives, this type of oil usually brings the highest price.

Those oils having asphalt as a base do not yield so large a percentage of gasoline on first distillation; they run down to a residue of heavy pitch, or asphalt. In order to increase the yield of lighter products, such as gasoline and kerosene, the product distilling over just following kerosene in the first distillation is, in many refineries, subjected to destructive distillation, called *cracking*. Asphalt base crude oil does not ordinarily produce lubricating oils.

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[1] For a list of the oil fields in which the various types of crude oil occur, see p. 3.

Mixed base petroleum contains both paraffin and asphalt, and is usually refined for gasoline and the lighter products, as well as for lubricating stock.

Location and Arrangement of Refineries.—With a certain type of crude oil available for refining, and certain products as an objective, the refiner constructs his plant with a view to operating in the most economical way consistent with production requirements. Wherever possible, refineries are situated near streams of water;[1] by this means there is an assured water supply, and in some cases there is also afforded a method of transportation. Many plants formerly discharged refuse into streams, but the practice gave rise to prohibitory legislation in several states, and has practically been discontinued.

In a properly planned and well-constructed refinery, advantage is taken of natural slopes for the flow of oil by gravity, all exhaust steam is utilized in some manner, refinery units are equipped with heat exchangers, and in fact every effort is made to effect possible economies. It has been said that the kindest compliment which can be paid by a visiting layman is, "The plant looks as if it were closed down." The inference is that the entire organization is functioning like a smoothly running machine under excellent management.

Those who are acquainted with the refining industry are aware that practically all of the large American refineries are so situated, geographically, as to assure them of a supply of crude oil for many years to come. It should be remembered that the useful life of a plant is limited by the life of the oil field from which it receives its crude petroleum.[2]

Two other very important factors influencing the selection of a refinery location, are those of railroad facilities and freight rates. As the refiner is obliged to meet competitive prices in marketing his products, the convenience of the location of the refinery must compensate for any increased freight rates that his location may entail. In order to secure shipping facilities, a considerable expenditure for the construction of railroad sidings is frequently required.

[1] Most of the large refineries at Tulsa, Okla., are on the banks of the Arkansas River; there are a number of large plants along the Mississippi and also along the Gulf coast.

[2] The refineries at Coffeyville, Kan., for example, are experiencing considerable difficulty in securing oil, on account of the decline in production of the Nowata, Okla. field.

Refining Procedure.[1]—Mention has been made that systems of refining are broadly divisible as to the intermittent, or *batch*, method of distillation, and the continuous method.

Refining is essentially a process of fractional distillation, and is made physically possible by the fact that the constituent hydrocarbons of petroleum have different boiling points. For example, New Navy gasoline is composed of hydrocarbons with boiling points of from 390 to 437°F., while the average kerosene has an initial boiling point of 390 and an end-point of 580°F.

After the crude petroleum has been fractionated in the first process of distillation, the various resultant fractions are further processed by means of chemical treatment, redistillation, filtration, blending, compounding, etc.

The two methods of refining above differ only in the first distillation process. Under the continuous method, which has in recent years come into very general use, the crude oil is pumped into the first of a battery of stills. Here the lighter products, which have a lower boiling point than subsequent products, pass off as vapor. The residuum is pumped, or flows by gravity, into the next still in the series, where increased heat is applied and products having a lower Baumé gravity, but higher boiling point, distill off. This same process continues until the residual oil has reached a point where its further processing must be done in another unit of the plant.

Where the batch method of distillation is employed, the successive products are removed in the same still, by means of gradually increasing the temperature of the oil. This latter method is illustrated in Fig. 7, page 150, and may be briefly explained as follows:

The crude oil is pumped from a storage tank into a preheater, and thence into the crude still; here it is subjected to a temperature of from 200 to 325°F., and open steam is in many refineries introduced into the still when the oil reaches a temperature of about 220°F. The steam has the effect of bringing over the first product, crude naphtha, at a lower temperature than otherwise would be the case, and also tends to avoid decomposition (*cracking*).[1]

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[1] The following account is only intended to present a very broad outline of refinery procedure, and readers who wish to inform themselves more fully upon refinery technology are referred to BELL, H. S., "American Petroleum Refining," BACON and HAMOR, "American Petroleum Industry," CAMPBELL, ANDREW, "Petroleum Refining," and DAY, DAVID T., "A Handbook of the Petroleum Industry." For data concerning the various tests which are applied to petroleum and its derivatives, see "Petroleum Products and Lubricants," Report of Committee D2, *Proc. Amer. Soc. Testing Materials*, vol. XXI, 1921.

The vaporized naphtha passes through tower and water-cooled condensers, and flows to a receiving house. Here a stillman keeps the stream under observation through a *look-box*, taking specific gravity and temperature readings at intervals of a few minutes. The look-box is connected, by means of a manifold, with a number of product storage tanks, and as the specific gravity of the stream changes, various *cuts* to products are made. The stream is run into crude naphtha storage until it reaches a Baumé gravity of about 54°, after which it is turned into the kerosene distillate tanks. Usually when the Baumé gravity reaches 38°, the product distilling off is changed over to the gas oil tanks and is allowed to run to perhaps 33° Baumé, before changing to the wax distillate tanks. From this point wax distillate is taken off until there remains in the fire still merely a tar residuum. It must be remembered that the practice outlined is only typical; each refiner has his own particular cuts, and pet theories of subsequent treatment.[2]

In the continuous method of distillation the cuts are made to products along the same general lines, a look-box being provided for each still in the battery.

Taking up in order the products obtained from the first distillation, the subsequent treatment of each will be somewhat as described in the following paragraphs.

Gasoline and Naphtha from Crude Naphtha.—The crude naphtha from the receiving house is conducted to temporary storage tanks through the product lines; from these tanks it is pumped into an agitator for chemical treatment with any or all of sulphuric acid,[3] litharge, *doctor* solution and flowers of sulphur. This treatment is accomplished by means of agitation with an air blast and washing with water, and is designed to remove

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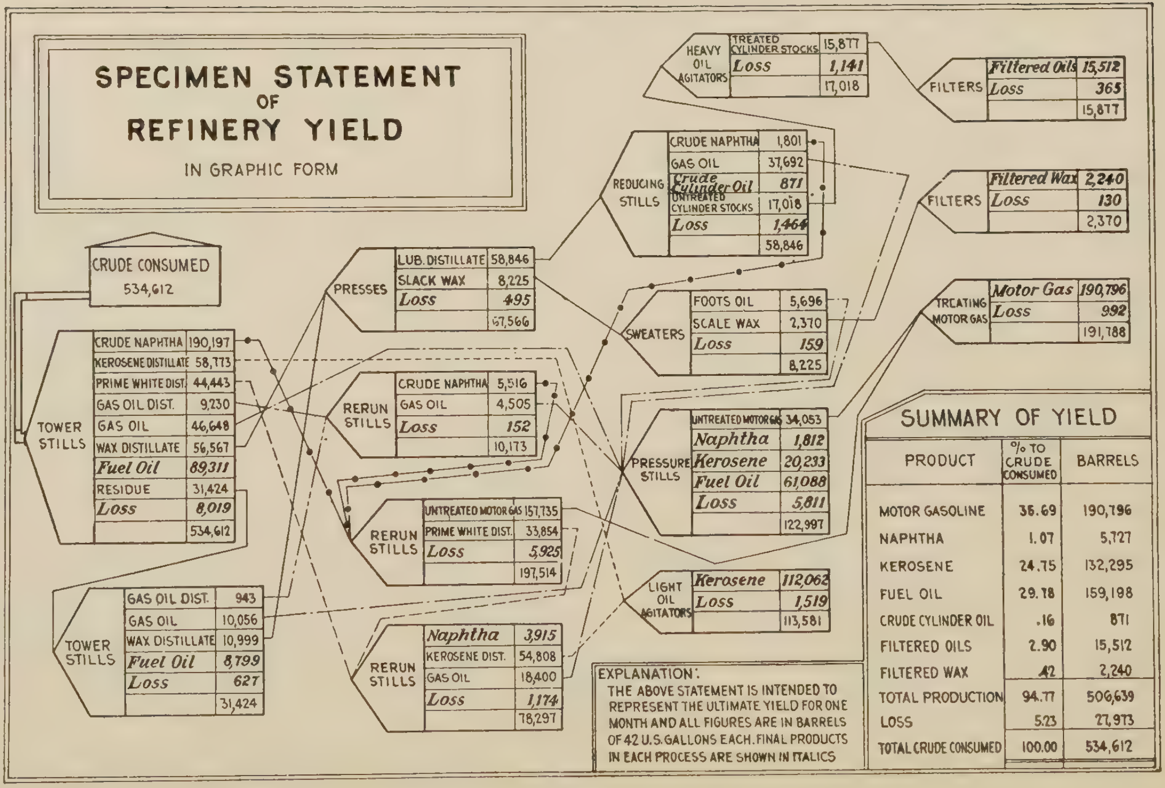
[1] Cracking is always avoided where the refiner is running the crude oil down to cylinder (lubricant) stock; in asphalt base crudes, cracking is resorted to in order to increase the yield of lighter products.

[2] Many refiners remove as many as seven or eight products in the course of the first distillation (see Fig. 6, which shows a specimen refinery yield of a plant treating Mid-continent oil).

[3] Most large refineries reclaim a portion of the sulphuric acid used, by treatment in a sludge acid separating tank.



SUMMARY OF YIELD

PRODUCT	% TO CRUDE CONSUMED	BARRELS
MOTOR GASOLINE	35.69	190,796
NAPHTHA	1.07	5,727
KEROSENE	24.75	132,295
FUEL OIL	29.78	159,198
CRUDE CYLINDER OIL	.16	871
FILTERED OILS	2.90	15,512
FILTERED WAX	.42	2,240
TOTAL PRODUCTION	94.77	506,639
LOSS	5.23	27,973
TOTAL CRUDE CONSUMED	100.00	534,612

EXPLANATION:
THE ABOVE STATEMENT IS INTENDED TO REPRESENT THE ULTIMATE YIELD FOR ONE MONTH AND ALL FIGURES ARE IN BARRELS OF 42 U.S. GALLONS EACH. FINAL PRODUCTS IN EACH PROCESS ARE SHOWN IN ITALICS

FIG. 6.

impurities such as sulphur, which impart an unpleasant odor and dark color to the untreated product.[1]

Following its treatment in the agitator, the treated naphtha is pumped into a steam still for further fractionation. Here one or more grades of motor gasoline are produced, together with naphtha, or *turpentine substitute;* the remainder of the still content is a wax distillate, ready for further treatment in other plant units. The gasoline and naphtha from the steam still are finished products, although most refineries do a certain amount of blending in order to produce some special trade gasoline.[2]

Kerosene from Water White (Kerosene) Distillate.—The kerosene distillate, taken off just following crude naphtha in the crude still, is next treated with caustic soda, litharge, and sulphuric acid, in a manner similar to that used for crude naphtha. It is then run into a bleacher tank, where it is allowed to remain for from 12 to 24 hours; the resultant finished product is commercial kerosene. Some kerosenes must be filtered in order to secure an acceptable color.

Gas Oil.—Gas oil, which distills over following the kerosene distillate in the crude distillation, may be considered to be a finished product,[3] or it may be used for *cracking stock.* Cracking in distillation is a comparatively recent innovation, the process having been discovered by accident. It involves the application of high temperatures in a cracking unit, the resultant destructive distillation constituting a chemical decomposition. Cracking results in the recovery of additional quantities of more volatile products.[4] In the refinery illustrated in Fig. 7 the cracking process is not employed.

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[1] Some authorities claim that a large portion of our available fuel supply is lost through the necessity for chemical treatment to meet popular demand for an odorless product.

[2] The recently exploited ethyl fluid is now being sold by ten of the large oil companies for mixing with motor gasoline. The process, developed by the General Motors Chemical Corporation, consists in treating gasoline with tetraethyl lead, the lead being neutralized with ethylene bromide. It is said that this treatment has no effect upon the volatility of the fuel, nor does it actually remove carbon, but that it increases the combustion efficiency of the gasoline. The danger from lead poisoning in the present mode of manufacture of the product, however, is likely to curtail its continued use.

[3] Gas oil is used for the manufacture of artificial gas.

[4] Those readers who are interested in the cracking of oils are referred to Dean, E. W. and Jacobs, W. A., "Production of Gasoline by Cracking Heavier Oils," *Tech. Paper* 258, Bureau of Mines, Department of Interior.

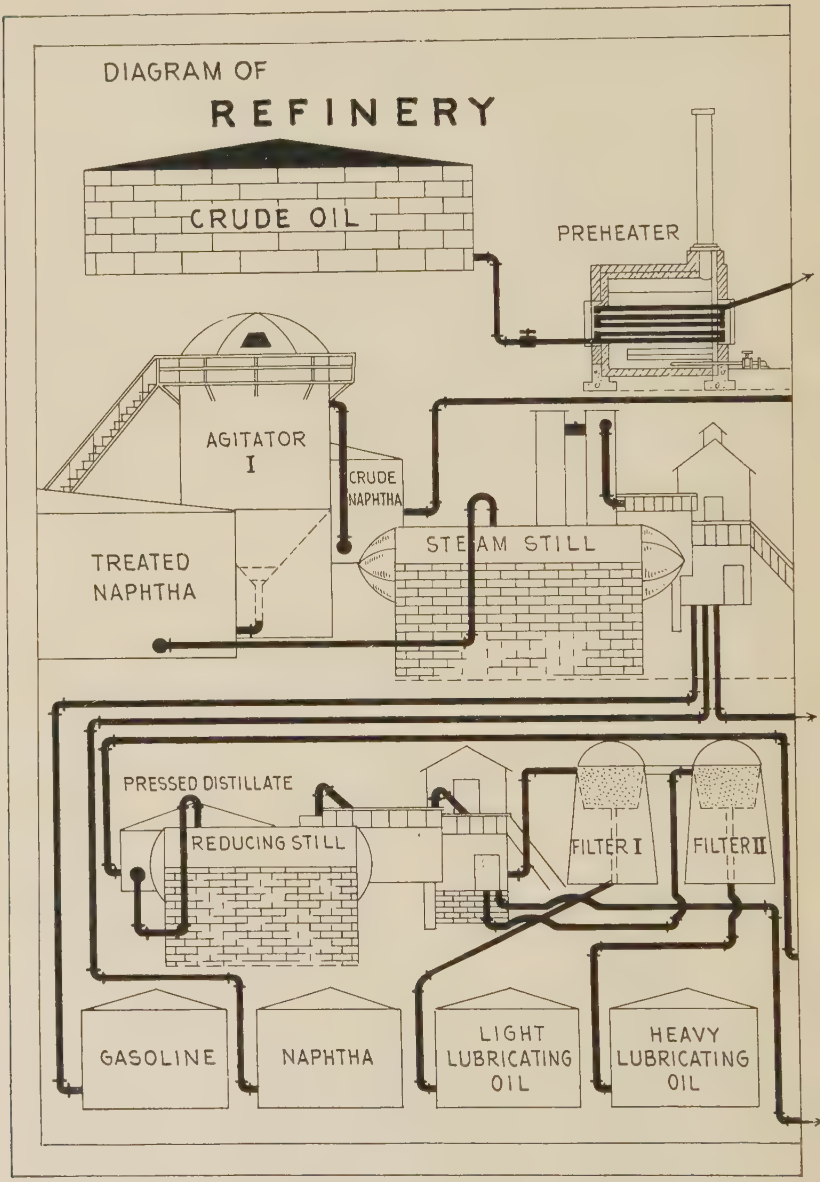
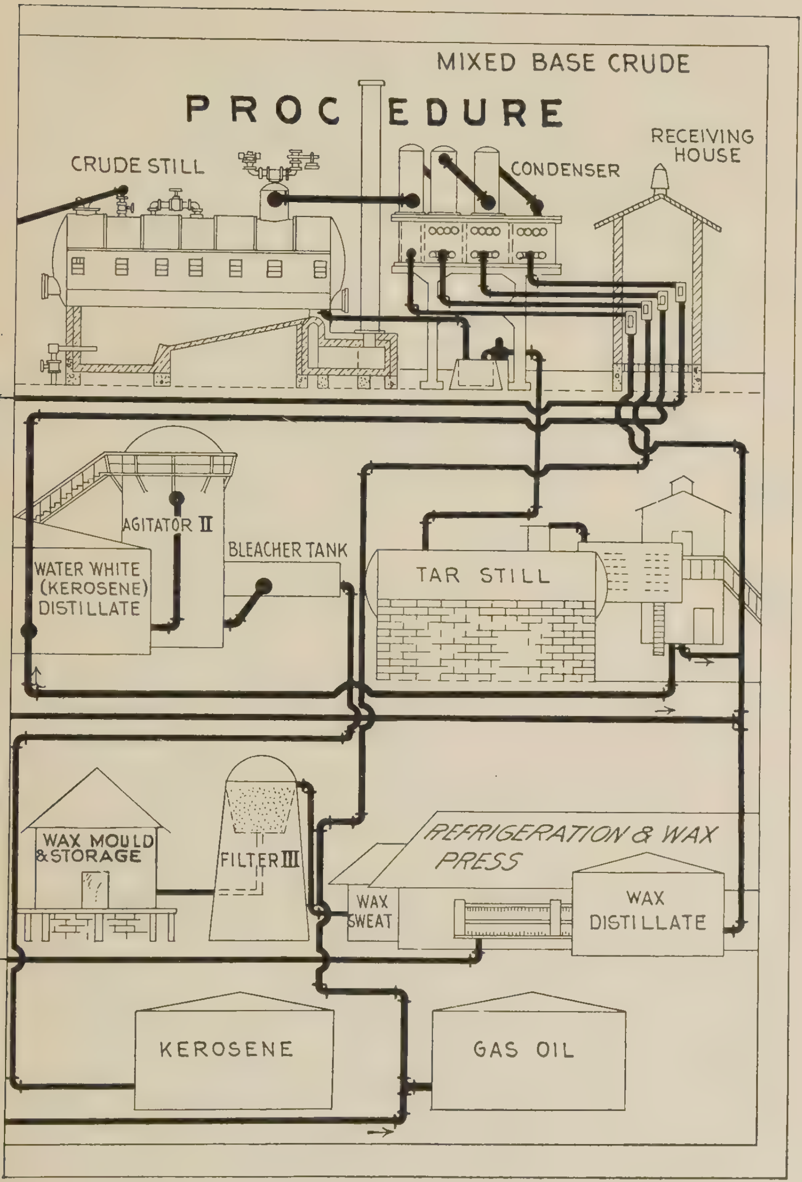


FIG. 7.—Diagram of



refinery procedure.

Wax Distillate, Wax and Lubricants.—The fourth cut in the crude still is wax distillate; a quantity of this product is also obtained in the steam still and in the tar still. In the plant illustrated the distillate is pumped into a refrigeration unit, where its temperature is lowered to from 20 to 15°F. It then enters a hydraulic filter press, where the chilled wax adheres to canvas blankets and pressed distillate drains off. The wax, known at this stage as slack wax, next enters sweat pans, where any remaining oil is removed by *sweating* with steam coils. The oil removed is termed *foots oil,* and is usually considered to be a finished product at this point. The wax obtained from the sweat pans is known as *scale wax,* and is ready for filtering through Fuller's earth and subsequent barreling. The pressed distillate is subjected to further distillation in a reducing still; here various grades of lubricating stock are obtained. These stocks are filtered through Fuller's earth, and are later compounded into various trade lubricants. Compounding practice differs widely among refiners, and according to crude oils. Lubricating oils must meet a number of tests, such as specific gravity, viscosity, cold, color, flash, fire, and pour tests. Both mineral and vegetable oils are used in blending and compounding although the latter must be used somewhat sparingly.

Tar Residuum.—The separation of gas oil and wax distillate in the first distillation may continue until a tar residuum is left in the still. This residual oil is often sold as *fuel oil,* a finished product, or may be subjected to further distillation in a tar still, where kerosene distillate and wax distillate are produced by cracking. The final residuum is then coke.

Skimming or Topping Plants, Etc.—Those plants which have been placed under group two are, in the main, but an application of some one of the processes employed in a complete refinery. Since all principles of operating will be essentially the same as in the complete refinery, no attempt is made to discuss this group separately.

Casinghead Gasoline Plants.—Casinghead gas has received serious attention only during the past ten or fifteen years. According to Bacon and Hamor, in their "American Petroleum Industry," a very crude plant was installed at Titusville, Pennsylvania, almost within sight of the famous Drake Well, in the fall of 1904.

Casinghead gas ordinarily yields from ½ to 8 gallons of natural gasoline per thousand cubic feet of gas, with an average yield of from 2½ to 4 gallons. The following table will serve to give the reader some idea of the size of the industry:

NATURAL (CASINGHEAD) GASOLINE PRODUCED IN THE UNITED STATES, 1911–1923
(U. S. Geological Survey)

Year	Number of plants	Gallons produced
1911	176	7,426,000
1912	250	12,081,000
1913	341	24,061,000
1914	386	42,653,000
1915	414	65,365,000
1916	596	103,493,000
1917	886	217,884,000
1918	1,004	282,535,000
1919	1,191	351,535,000
1920	1,151	384,743,000
1921	1,200	449,934,000
1922		505,832,000
1923 (estimated)		600,000,000

Casinghead gasoline is highly volatile, or *wild*, its Baumé gravity ranging usually from 80 to 100°. One of its principal uses is for blending with refined gasoline, the object of this blending being to raise the Baumé gravity of the refined product. In many cases refiners run casinghead gasoline into the oil lines with crude petroleum, later distilling it out with the other gasoline. It may be mentioned that this practice will be likely to increase to a considerable extent the line losses from evaporation.

The volatility of casinghead gasoline makes its storage under pressure advisable. In order to obviate certain objectionable features of the ordinary storage tank, especially its tendency to spread under pressure, a spherical tank has been brought out by one manufacturer.

Absorption Method of Manufacture.[1]—In the absorption process, which is considered to be the more efficient and economical of the two methods in general use, the gas, after having been cooled, is either sprayed with or bubbled through absorbent oil. This absorbent oil dissolves the gasoline content in the gas and after passing successively through a vent tank and a heat exchanger, enters a still where the gasoline is refined out of the absorption medium, and condensed into gasoline. The heated oil returns to the heat exchanger where it imparts heat to the incoming gasoline-bearing oil, after which it is cooled and returned to the absorbers. Absorption (straw) oil generally has a Baumé gravity of from 34 to 36°, and an initial boiling point of about 536°F.

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[1] Those readers who are interested in the detailed processes used in this method of manufacture are referred to BURRELL, GEORGE A., BIDDISON, P. M., and OBERFELL, G. G., "Extraction of Gasoline from Natural Gas

Compression Method of Manufacture.[1]—The compression method is suitable only for gas with a large gasoline content, the absorption method being always used with the *leaner* varieties of gas.

Under the compression method, pressure is applied to the gas and the compressed gas cooled in coils over which water is run. There is in practice considerable latitude in the amount of pressure used, varying from about 80 pounds per square inch to as much as 250 pounds per square inch, and more. Where high pressures are used the compressor system is usually divided into two units with water-cooling after each compression, and the condensed gasoline drawn off after each cooling.

In some districts large plants, with as many as ten or twelve compressors and a daily capacity of as much as 40,000 gallons of gasoline, are in use; a series of smaller plants has, however, the advantage of less danger from explosion, the convenience of being able to shut down a single unit without closing down altogether, and the additional advantage of being able to reduce the capacity from time to time as the available supply of gas is reduced. In cases where a steady supply of gas is assured, the larger plants can be run with greater economy.

General Remarks.—It should be understood that any operating practices explained herein are intended merely to convey a general plan of procedure to the reader. Some of the treatises to which footnote references have been made, are the works of

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by Absorption Methods," *Bull.* 120, Bureau of Mines, Department of the Interior, as well as to "Handbook of Casinghead Gas" edited by the late Westcott, Henry P., Metric Metal Works, Erie, Pa.

[1] For a complete outline of the compression method of manufacture, see Dykema, W. P., "Recovery of Gasoline from Natural Gas by Compression and Refrigeration," *Bull.* 151, Bureau of Mines, Department of the Interior.

well-informed and widely recognized technologists, and are worthy of careful perusal, even by the accountant.

At the present time, several eastern universities are offering courses in the subjects both of Petroleum Engineering and Refinery Technology, and similar courses have recently been added to the curriculum of the University of California. Since petroleum refining is still in the experimental stage, in spite of the enormous forward strides which have been made during the past few years, and since large refineries are inclined to keep their operating methods confidential, the student may experience some difficulty in securing information first hand, and may even be obliged to content himself with general observations, supplemented by data gained from current literature on petroleum technology.

It may be mentioned that all but temporary storage is considered in this volume as falling within the province of pipe-line operations, while marketing by tank car, etc., is treated as a function of a special marketing company. In point of fact these distinctions may not exist in many companies, and are made here only for the convenience of presentation.

CHAPTER XV

CAPITAL ASSETS AND DEPRECIATION

As has been indicated in Chap. XIV, refineries may be classified into three groups. A tendency toward putting into effect unproved, and even unsound, ideas of construction and general layout is more pronounced in the cases of skimming, topping, compounding, casinghead gasoline, and similar plants, than in the case of complete refineries. This fact seems to be the result of a desire among operators of small plants to construct new plants in accordance with ideas which they have formulated during operating experience; unfortunately, many of them are deplorably deficient in genuine technical knowledge, such as is absolutely necessary even in the broadest planning of a contemplated refining unit, and the result of their efforts is often a poorly planned, disjointed series of processes, which cannot help resulting in the loss of money from the start. The construction of complete refineries involves such a considerable expenditure, that most large plants are erected by competent engineers.

Another important feature of refinery construction which seems to have received very little thought in several cases, is that of geographical location, especially in connection with the crude-oil supply.[1]

Classification of Capital Asset Accounts.—Since a refinery's operations are readily divisible into processes, the logical division of the capital asset accounts is by refining units. For example, if the crude still unit includes the crude stills, condensers, and receiving house, it is much more desirable that all investment in equipment of the unit be charged into one controlling account, than to charge all stills into one account, all condensers into another, and so on. Further subclassification of the equipment can be arranged, though this can more conveniently be done in a subsidiary ledger or card record.

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[1] A very notable example of an ill-advised construction program, as well as of gross mismanagement, is the case of a large American company. Besides several plants in other fields, the company owns three refineries in the Mid-continent field. All three of the plants were constructed at locations which gave no assurance of a continued crude-oil supply, and the production from the company's own properties is negligible. As a consequence, one of the plants has been closed down for more than a year, while the other two are operating only a portion of the year.

In the classification of accounts here presented, investment in fixed assets has been divided into six main classes, as follows:

1. Land.
2. Process equipment:
    - Crude still unit (Process I).
    - Agitator and steam still unit (Process II).
    - Tar still unit (Process III).
    - Hydraulic filter-press unit (Process IV).
    - Sweater and wax-finishing unit (Process V).
    - Reducing still unit (Process VI).
    - Lubricants filter unit (Process VII).
    - Kerosene finishing unit (Process VIII).
3. Service equipment:
    - Steam plant.
    - Pumping plant.
    - Water wells and equipment.
    - Electric plant.
    - Sulphuric acid reclamation plant.
    - Fuller's earth burning plant.
    - Crude and unfinished product tanks.
4. General equipment:
    - Warehouse.
    - Office.
    - Laboratory.
    - Finished product tanks.
    - Pipe and fittings.
    - Machine shop and tools.
    - Railroad sidings.
    - Delivery facilities.
5. Automobiles and trucks.
6. Furniture and fixtures.

There are also included accounts for construction in progress and reserve for depreciation.

Land.—The account for land should be charged with the cost of the refinery and crude oil storage tank sites, together with any expense incidental to acquisition. It is intended that the account include the cost of all lands used in the refinery operations, and any property acquired for investment purposes should therefore be included in a special account under investments.

Process Equipment.—As has been mentioned, all refining equipment should be classified by operating units. This practice will be found convenient in every way, and will greatly simplify the work of computing depreciation chargeable to costs. It will be borne in mind that the accounts suggested are designed for a particular refinery (see Fig. 7, page 150) and, therefore, will not fit any other refinery without modification.

Service Equipment.—By service equipment is meant the equipment of all plant units engaged in rendering service to other units of the refinery. In general industrial cost accounting these are termed service departments, as distinguished from production centers. Each of the accounts listed is a controlling account, and may be further subdivided in a subsidiary record.

General Equipment.—The accounts which are shown under this caption are designed to include such refinery equipment as is of a general nature; the expenses of operating will be allocable to costs upon some predetermined basis (see Chap. XVI), or else will be chargeable to selling expenses or a similar account.

As in the cases of process equipment and service equipment, these accounts may be further subclassified in a subsidiary record.

Plant Investment Record.—In order that a proper analysis of any of the foregoing controlling accounts may be available, the company should maintain a subsidiary plant investment record. This may be kept either in ledger form, or on cards; whichever form is selected should show the following information:

Classification (as Process Equipment, Service Equipment, etc.).
Plant unit (as Crude Still Unit, Railroad Sidings, etc.).
Name of item and brief description.
Company's designating number.
Manufacturer's number.
Size, capacity, rating, etc.
Material from which constructed.
Lineal length (when relevant).
Date purchased.
Purchased from.
Cost.
Depreciation rate applicable.

The form may also have space provided for depreciation sustained, and it will then furnish a complete and up-to-date record which will be readily available when any unit of equipment is retired from service or sold. It will also insure that no depreciation is calculated upon assets which have been fully depreciated.

The most convenient system of arrangement of the subsidiary record is first according to plant units, and then alphabetically. For example, under crude still unit, the items might be somewhat as follows:

Condenser boxes.
Condenser pipe and fittings.
Foundations and masonry, stills.
Pumps, engines and boilers.
Receiving house building.
Receiving house equipment.
Shells and equipment, stills.
Thermostats, etc.

Authorizations and Construction in Progress.—The employment of an authorization system has several advantages. It places the responsibility for the undertaking of the construction work upon responsible executives, and insures that each job is subject to definite control by the management. It also furnishes a complete record of the work covered, including separate costs on each job.

No special form of authorization is suggested, but the form selected should show, among other things:

Date.
Serial number.
Location of proposed work.
Nature of proposed work.
Why necessary.
By whom recommended.
Estimated cost, detailed in round figures.
Estimated time required to complete.
Estimates made by.
By whom work is to be undertaken (name of contractor).
Approval.

The construction in progress ledger sheet should show the information disclosed by the authorization, and should carry the same serial number. In some cases it has been found feasible to design the authorization in a manner such that the lower portion of the sheet serves as a ledger record of the various charges and credits to the account.

The several jobs should be closed out to capital assets as the work is completed. The record will be controlled by the general ledger account Construction in Progress.

Depreciation of Equipment.—Although some attempt has been made to arrive at a composite rate of depreciation for refineries as a whole, the results obtained are seldom satisfactory for practical purposes. The writers are of the opinion that the straight-line method is the only practical one which can be used.[1] Under this method, each class of equipment is written off the books over the term of its useful life, the same annual charge being made to depreciation expense each year. The following rates of depreciation are recommended by the Treasury Department in the *Manual for the Oil and Gas Industry,* and are the result of exhaustive research work:

	Annual Rate, Per Cent
Distilling equipment (stills, condensers, agitators, etc.)	15
Power plant (boilers, engines, electrical equipment, etc.)	10
Buildings	5
Buildings—skimming plants	10
Storage (all kinds)	8
Pipes and fittings	12
Lubricating plant (filters, presses, chillers, grease plant, etc.)	10
Miscellaneous (loading racks, machine shop, laboratory, etc.)	10

The following recommendations with regard to the useful life of a plant as a whole are based by the government on its survey of conditions:

	Useful Life, Years	Depreciation Rate, Per Cent
Well-constructed refinery plants located on the Atlantic coast or Gulf coast or at points that are assured of a supply as long as there is production east of the Rocky Mountains or from Mexico	20	5
Refinery plants of good construction located on trunk pipe lines or where a supply of crude is assured for several years	10	10
Skimming plants and small refineries of poor construction or located at points where the supply of crude is not assured for a long period of time	6	16⅔
Natural gas gasoline plants	4	35–20–15–10 (salvage 20)

Whenever it is found that the refinery as a whole is likely to outlast the life of the oil field upon which it is dependent for its crude oil supply, the plant should be depreciated on the basis of the estimated life of the oil field.

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[1] The general principles of the various methods of calculating depreciation, have already been discussed in Chap. VI.

CHAPTER XVI

LABOR, STORES AND EXPENSE

The cost of operating a crude petroleum refinery may first be broadly classified as to the three elements of refining expense:

Labor.
Stores used.
Miscellaneous expense.

Since a refinery really comprises a group of closely related activities, or processes, the three elements of operating cost should be further classified as to the particular activity for which expended. Having thus determined the total cost of operating each process for a period, the first step will have been accomplished toward the objective of finding the cost of producing each of the various commodities.

Classification of Expenses.—The expenses of operation will fall naturally into groups, each of which may be still further subdivided. In the classification here presented, the accounts are as follows:

Process costs (see Forms 22 and 23*a*, pages 213 and 214):
  Product used.
  Labor.
  Fuel used.
  Chemicals, supplies, and expense.
  Repairs.
  Depreciation.
  Taxes and insurance.
  Service departments and general expense.
Service departments:
  Steam plant expense.
  Pumping expense.
  Water wells expense.
  Electric plant expense.
  Sulphuric acid reclamation expense.
  Fuller's earth burning expense.
  Storage expense, crude and unfinished products.

- Clearing accounts:
  - Payroll.
  - Depreciation.
  - Taxes and insurance.
  - Miscellaneous refinery payroll and expense.
- General refinery:
  - Warehouse expense.
  - Laboratory expense.
  - Commissary and restaurant.
  - General repairs.
  - Injuries and damages.
  - Depreciation.
- Selling:
  - Finished product storage.
  - Delivery facilities.
  - Advertising.
  - Traveling and automobile.
  - Salaries, commission and expenses.
- Administration:
  - Executive salaries.
  - Office salaries.
  - Office supplies and expenses.
  - Traveling and automobile.
  - General taxes.
  - Legal and auditing.
- General:
  - Charitable contributions.
  - Interest.
  - Income tax.
  - Provision for contingencies.

Process Costs.—The Voucher Record (Form 26, page 218) provides but one column for process costs; a complete analysis of all postings to this column should be made in the *Process Expense Analysis* (Form 22, page 213). This record should be kept by processes, a separate sheet being used for each. It will be posted direct from the Cash Voucher (Form 27, page 219) and from journal vouchers in respect of the apportionable amount of clearing accounts, etc. At the end of a period, after all service and clearing accounts have been closed out, the totals of each of the columns should be carried into the spaces provided therefor on Form 23*a* (page 214), *Process Cost Ledger*, where a sheet must also be kept for each process. For a detailed explanation of the procedure from this point, in finding costs, including the method to be used in apportioning to each process the cost of the unfinished product used, see Chap. XVII.

The account *Labor* should include all labor in connection with the operation of the refinery unit under consideration, and may further be subdivided in the company's discretion. For example, the crude still unit labor might be divided as to:

Firemen.
Stillmen.
Helpers.

The charges will come from the monthly (or semi-monthly) clearance of the Payroll account.

Fuel used, in the majority of cases, will be fuel oil from the company's stocks. This should be charged at the stock cost for the previous month, the quantities consumed by the various units being based upon information furnished by the daily tank gage report (Form 21, page 212).

Chemicals, supplies, and expense should include stores and supplies used, as for example, waste, packing, etc., and sulphuric acid and other chemicals used in the agitators and filters. The account should also be charged with any other expenses of a miscellaneous nature for which separate provision is not made.

The account *Repairs* should include all expenses, both labor and repair parts, of maintaining the process unit. Items of repair which are extraordinary in amount, occasioned by explosion, cyclone or similar causes, should not be charged into the repairs of a single month, since such a charge would grossly distort the month's costs. In these circumstances the amount may be suspended and apportioned over the operations of several months. An alternative and perhaps better method, which is quite sound in accounting principle, is to charge the amount off as an extraordinary expense of doing business, not permitting it to enter process costs at all.

From the monthly computations of depreciation sustained, the amount attributable to each operating unit should be charged to the *Depreciation* account. The determination of the amount sustained in the case of each unit is greatly facilitated by the practice of classifying the capital asset accounts according to processes.

The *Taxes and insurance* found to be allocable to each process, should be charged to the account provided; the amount will come from the taxes and insurance clearing account.

The ratable share of all service department expenses should be charged into the account *Service departments and general* *expense,* upon the basis indicated in the following discussion of service departments.

Service Departments.—Before taking up the various service departments for discussion, it might be well to deal with the subject along broad and general lines, especially with regard to the mechanics of clearing out the accounts each period, to the benefiting units. In the first place, it is necessary that some basis be selected, in the case of each service unit, for allocating the cost of its operations to the several plant units. In each case in the following discussion, a basis is suggested. The next problem which presents itself is that of clearing the accounts between each other in the simplest manner, without impairing the value of the resultant figures.

Let us first illustrate a method which, although theoretically correct, is somewhat involved. Assume the following total expenses under each service account before clearance has been made to the other accounts within this particular group:

A. Steam plant expense	$ 523.00
B. Pumping plant expense	170.00
C. Water plant expense	106.00
D. Electric plant expense	201.00
Total	$1,000.00

Further assume that the expenses of these service departments are fairly allocable to each other, and to all other departments and process costs, in the following ratios:

Plants	Allocable to—				
	Steam, per cent	Pumping, per cent	Water, per cent	Electric, per cent	All other, per cent
A. Steam	..	8	4	19	69
B. Pumping	9	..	17	3	71
C. Water	22	3	..	2	73
D. Electric	5	18	..	..	77

The solution of the problem as to the cost of these departments to all other departments and processes, may then be calculated as shown below:

Let *a*, *b*, *c* and *d* represent net expenses of steam, pumping, water, and electric plants, respectively, chargeable to process costs and other service departments.

Then, in dollars:

$$\begin{aligned} a &= .69\,(523 + \tfrac{9}{71}b + \tfrac{22}{73}c + \tfrac{5}{77}d) \\ b &= .71\,(170 + \tfrac{8}{69}a + \tfrac{3}{73}c + \tfrac{18}{77}d) \\ c &= .73\,(106 + \tfrac{4}{69}a + \tfrac{17}{71}b) \\ d &= .77\,(201 + \tfrac{19}{69}a + \tfrac{3}{71}b + \tfrac{2}{73}c). \end{aligned}$$

Removing brackets and reducing all fractions to three places of decimals, we have:

$$\begin{aligned} a &= 360.87 + .087b + .208c + .045d \\ b &= 120.70 + .082a + .029c + .166d \\ c &= 77.38 + .042a + .175b \\ d &= 154.77 + .212a + .032b + .021c. \end{aligned}$$

Eliminating c from the equations by substituting its value, as shown in the third equation above, in the other three equations:

$$\begin{aligned} a &= 360.87 + .087b + (16.09 + .009a + .036b) + .045d \\ b &= 120.70 + .082a + (2.24 + .001a + .005b) + .166d \\ d &= 154.77 + .212a + .032b + (1.62 + .001a + .004b) \end{aligned}$$

Grouping the items in each equation we have:

$$\begin{aligned} .991a - .123b - .045d &= 376.96 \\ -.083a + .995b - .166d &= 122.94 \\ -.213a - .036b + d &= 156.39 \end{aligned}$$

Bringing the d value in the first two equations to unity (to correspond with the third) we have:

$$\begin{aligned} 22.022a - 2.733b - d &= 8{,}376.80 \\ -.500a + 5.994b - d &= 740.59 \\ -.213a - .036b + d &= 156.39 \end{aligned}$$

Adding the first and third, and second and third equations (thus eliminating d) we have:

$$\begin{aligned} 21.809a - 2.769b &= 8{,}533.19 \\ -.713a + 5.958b &= 896.98 \end{aligned}$$

Now, dividing the first equation by 2.769, and the second by 5.958 (in order to bring b to unity) we have:

$$\begin{aligned} 7.876a - b &= 3{,}081.69 \\ -.120a + b &= 150.55 \end{aligned}$$

Adding, we have,

$$7.756a = 3{,}232.24$$

and, therefore,

$$a = \underline{\$416.74}$$

Substituting this value of a in the equation above, *viz.:*

$$-.120a + b = 150.55$$

we have,

$$\begin{aligned} b &= 150.55 + 50.01 \\ &= \underline{\$200.56} \end{aligned}$$

Taking the c equation before it was eliminated from the other three equations, that is,

$$c = 77.38 + .042a + .175b$$

and substituting the a and b values ascertained, we have,

$$\begin{aligned} c &= 77.38 + 17.50 + 35.10 \\ &= \underline{\$129.98} \end{aligned}$$

and finally substituting the a, b and c values in the equation,

$$d = 154.77 + .212a + .032b + .021c$$

We arrive at a value for d of,

$$\begin{aligned} &154.77 + 88.35 + 6.42 + 2.73 \\ &= \underline{\$252.27}. \end{aligned}$$

The service department expenses chargeable to other departments or processes are (after taking up a difference of 45 cents due to the fact that the calculations were only made to three places of decimals), therefore,

Steam plant	$ 416.94
Pumping plant	200.66
Water plant	130.03
Electric plant	252.37
	$1,000.00

It will be seen from the above example that, while an algebraic solution to the clearance of service accounts is possible, its application is likely to become tedious, especially where there are large numbers of accounts. The example here cited is not an extreme one; as a matter of fact it may be taken as fairly representative of the average clearing account problem. Its solution required about two hours.

The preferable practice is to establish a definite sum to be transferred from each clearance account to any other receiving service, these transfers to be made each month before closing the various service accounts to process costs, etc. Periodically, say every 6 months, the basis in use may be verified by an algebraic computation.

Steam Plant Expense.—This account should include all expenses of operating the steam or boiler plant, including any sums which may be selected as chargeable from other service departments for services rendered. In order that each department served may be charged with a ratable amount of the steam plant expense, a service table in some such form as the following, should be compiled:

DEPARTMENT	STEAM REQUIRED IN POUNDS PER DAY	PER CENT TO TOTAL
Crude stills	40,000	20
Steam stills	72,000	36
Light oil agitators	6,000	3
Pumping plant	16,000	8
Water plant	8,000	4
Electric plant	38,000	19
Other	20,000	10
	200,000	100

Based upon this average demand, the expense may be apportioned; where for any reason some unit fails to use its average demand, the table may be adjusted from time to time. The steam plant should render a periodical report concerning steam delivered to the several departments and processes.

Pumping Expense.—The Pumping Expense account should include all expense of moving the crude oil and products from one point to another by means of pumping. It should be closed out to units benefiting, at the end of each period, on the basis of the quantities handled. A running schedule may be kept, showing from month to month the quantities pumped into and out of each process or other plant unit; the information contained in this schedule will be obtained from Forms 23*b*, 24 and 26 (pages 215, 216 and 218). The cost of pumping crude oil and unfinished products should be considered as a part of the costs, but any expense of handling finished products after they have been placed in storage should be treated as a selling expense.

Water Wells Expense.—The cost of operating water wells, and of delivering water to the various plant units, should be included in this account. Water can be metered, of course, but this is seldom worth the trouble involved. The better plan for securing a basis of allocating the water system expense, is to require a periodical report from the water department of approximate deliveries.

Electric Plant Expense.—The apportionment of the electric plant costs should be based on metered consumption, but also should take into consideration a demand factor. Since a sufficient supply of energy must be available to meet, say, 75 per cent of the entire connected load, each connected plant unit must bear a pro-rata share of the expense of maintaining this available energy, whether or not it actually consumes its quota of current during the period. An example of such a method is shown below.

Assume a connected load to the various units totalling 3,350 horsepower, and 75 per cent of the operating expense of the plant to be in the neighborhood of $335. A minimum charge to the benefiting units may then be:

	Load, Horse-Power	Minimum Charge
Steam plant	750	$ 75.00
Pumping plant	910	91.00
Crude stills	520	52.00
Steam stills	520	52.00
Agitators	325	32.50
Wax plant	325	32.50
Total connected load	3,350	$335.00

The results for a particular month show total expenses for the plant, after clearances from other service deparments, of $500, and a total power consumption of 15,000 horsepower-hours. The division of the expense might therefore be as follows, all expense above the regular minimum being apportioned on the basis of current consumed:

Unit	Consumed		Minimum charge	Balance of expenses	Together
	Horsepower-hours	Per cent to total			
Steam plant	750	5	$ 75.00	$ 8.25	$ 83.25
Pumping plant	2,700	18	91.00	29.70	120.70
Crude stills	3,900	26	52.00	42.90	94.90
Steam stills	3,000	20	52.00	33.00	85.00
Agitators	2,100	14	32.50	23.10	55.60
Wax plant	2,550	17	32.50	28.05	60.55
	15,000	100	$335.00	$165.00	$500.00

Sulphuric Acid Reclamation Plant.—Many companies maintain plants for recovering sulphuric acid from the sludge acid drawn from the agitators. No difficulty should be encountered in securing the cost of operating a plant of this kind. The reclaimed acid should be charged into stores and supplies at the cost of reclamation.

Fuller's Earth Burning Expense.—The cost of operating vertical gravity ovens, or rotary kilns, for the purpose of regenerating used Fuller's earth, should be determined separately. The burnt clay should be charged into stores and supplies at the cost of burning.

Storage Expense, Crude and Unfinished Products.—This account, further subdivided where desirable, should include the entire cost of storing the crude oil and the unfinished products. It should be remembered, in this connection, that the refinery accounts here presented do not contemplate the operation of a tank farm for crude oil; the storage of crude oil is considered to be a function of the pipe-line department.

The expenses of operating the storage facilities may be cleared out to benefiting units periodically, on the basis of storage capacity applicable to each. Where some unit cannot conveniently bear its ratable share, the schedule may be altered to meet the circumstances.

Clearing Accounts.—To assure clear records, and to have available certain frequently needed information, the practice of treating: Payroll, Depreciation, Taxes and insurance, and Miscellaneous refinery payroll and expense, as clearing accounts is recommended. Occasion often arises when it is required to know the total amount of the refinery payroll; for example, in connection with computing employers' liability insurance. The same is true for different reasons in the case of the other accounts listed.

Payroll.—The company's payroll should be classified along the same lines as are indicated in the appended classification of accounts. After the periodic payroll has been set up by charge to the payroll clearing account and credit to salaries and wages accrued, a subsequent journal voucher should be made, closing out the clearing account to the various processes and general refinery units. General superintendence may be apportioned to units, on the basis of labor hours chargeable to each. It is suggested that the basis of *labor amounts* be avoided, since it has the effect of apportioning to units requiring the work of high-salaried men, considerably more superintendence costs than to those units where low-waged employees are used. As a matter of fact, this is exactly contrary to the facts, for the low-waged men will nearly always require the larger proportion of the supervision.

Depreciation.—The allocation of depreciation sustained to the various units should occasion very little difficulty, since the capital asset accounts will be classified in the same manner as the expenses of the plant units. A running schedule, kept by units, should be maintained; for the sake of convenience, the monthly computations may be based on balances at the beginning of the month, each month's additions being depreciated beginning in the month following that in which they enter service.

It may here be remarked that any large charges, which partake more of the nature of replacement than depreciation charges, should be accumulated in a separate reserve account. An example is furnished in the lead linings of agitators which, although protected by acidproof brick, must be replaced frequently.

Taxes and Insurance.—With the exception of employers' liability insurance, taxes and insurance may be apportioned to plant units on the basis of investment values. This is considered the logical and most equitable basis, since insurance premiums are fixed according to the value of the subject matter; state, county, and school taxes are usually equalized to taxpayers on the basis of assessed valuations.

The reader must remember, however, that such insurance as is carried on plant units involving the insurance company in a considerable risk, may have to be charged directly to the expense of the unit in question. This is largely a matter of judgment, and the basis of investment values should be resorted to only when a more direct one does not present itself.

It will be understood, of course, that the foregoing remarks will not apply to such taxes as Federal and state income taxes, capital stock, franchise, and similar charges. These are either administrative or selling expenses; income taxes are generally considered to be an extraneous deduction from net income.

Employers' liability insurance should be apportioned to units upon precisely the same basis as computed by the insurance company; increased rates are in force for men engaged in more or less hazardous work, and the insurance company, for this reason, bases its charges upon the company's division of payroll.

A taxes and insurance schedule can be conveniently maintained, and from this schedule the monthly charges to expense will be readily determined.

Miscellaneous Refinery Payroll and Expense.—While it is intended that this account serve to record all general plant burden not specifically allocable to any particular processes, it should not be used to cover a multitude of sins! The account may be cleared upon the basis of payroll labor hours chargeable to the various units.

General Refinery.—Although there may be some merit in a contention that any expense at the refinery should finally enter costs, conservative practice dictates that certain of the expenses, such as:

Warehouse expense,
Laboratory expense,
Commissary and restaurant,
General repairs,
Injuries and damages, and
General depreciation,

are better considered as general expenses of doing business.

There is no doubt that a certain portion of the *Warehouse expense* could quite properly be charged to the plant units receiving warehouse stores and supplies. On the other hand, to determine just how much or how little of this expense theoretically attaches to such stores issues, is quite a difficult matter. Not infrequently, certain large repair parts, occupying a considerable space in the warehouse, and perhaps requiring an unusual amount of care and attention, must be carried for long periods of time. As a matter of fact, the operating policy which requires these emergency repair parts to be held in readiness is really entirely separate from the company's production costs.

The *Laboratory expense* will be composed chiefly of chemists' salaries, together with sundry supplies and expense. The activities of the department will apply both to the operating and to the marketing divisions. The relatively small amount of the laboratory expense will hardly warrant clearing the account to benefiting units, and it will save considerable work to treat the total expense as a general charge to the operations of the refinery as a whole. Should the company desire to clear the account, however, a service rendered report should be required from the chief chemist each month, and this should be used as a basis for the charges to benefiting units.

The *Commissary and restaurant* accounts will probably result in a loss. This loss may be regarded in the light of either additional compensation paid to workmen, or as a general policy expense. Where its amount is sufficient to warrant clearance to the several operating accounts, the charges to units should be based upon the number of meals served to the different departments. This information can be secured by requiring the commissary department to keep a record by departments of workmen served.

The account *General Repairs* should include the cost of maintaining office buildings, fences, time-clock houses, and similar items of equipment; it may be subdivided in the company's discretion, but should not be cleared into costs. In the case of accident to equipment from explosion, lightning or like causes, the cost of repairing or replacing the damaged refinery units may be included here, rather than as a charge to repair accounts under the processes.

Injuries and damages should be charged with the cost of medical attention to injured employees, as well as with injury compensation paid; it may also include wages paid the workmen during the period they are obliged to be absent from work. Several companies include employers' liability insurance premiums in this account.

The account *Depreciation* under general refinery, will receive a monthly charge from the depreciation clearing account, and should embrace the depreciation sustained on such items as office buildings, fire-fighting apparatus, fences, etc.

Selling Expenses.—While it would appear to be quite unnecessary to discuss each of the subdivisions of selling expense separately, it should be pointed out that the refinery here contemplated is considered as marketing the major portion of its production through a special marketing company; some small number of sales to outsiders will occur, however, and these are considered as being made direct from the seller's refinery in the buyers' tank cars. For a more complete outline of marketing accounts see Part IV.

Labor.—Most refineries employ the time-clock system for securing a payroll time record, each workman reporting his employed and unemployed time. Except in the cases of men who are engaged in several different kinds of work during a day, the workmen's names may be arranged in the payroll record by processes and departments. The case of the few that work at several different points may be met by entering the workman's name under each of the processes or departments in which he spends some time.

No special form is suggested for the payroll record, although something along the same general lines as Form 7 (page 90) will be required. Care should be exercised that each payroll is properly approved by the refinery superintendent, as well as some other executive. A safeguard against padding is afforded by requiring all pay checks to be signed both by the refinery superintendent and by an accounting executive. The checks should be passed out by the foremen in the various departments, but periodically, without previous notice, this work should be undertaken by a representative of the accounting department.

The exact amount of each payroll should be transferred into a separate bank account, and pay checks issued thereagainst. Any checks outstanding for more than two months should always be made the subject of special enquiry, and any checks for which the employee does not call after the lapse of a reasonable time, should be redeposited in the bank and set up in a liability account captioned *Uncalled-for Pay Checks.* Such items should be brought to the attention of the refinery superintendent at regular intervals.

Material Stores.—The company's stores and supplies should be in the charge of a competent storekeeper, and should be issued only upon properly approved requisitions. A perpetual inventory record should be maintained of the stores; this is preferably kept in the storekeeper's department, and should show both quantities and amounts. Since the methods recommended for recording the receipt and issue of stores have received general discussion in Chap. V, the reader is referred thereto for further information.

Once or twice each month all requisitions upon which stores have been issued should be summarized by the accounting department, and a distributing journal voucher prepared.

Crude Oil and Product Storage Accounting.—Practically all of the American refineries operate on the 24-hour basis, a gage being taken of the contents of all tanks at 7 a.m. each morning.

In order that a complete record may be kept of all oil and product movements, the *Daily Tank Gage* (Form 21, page 212) must be prepared. It has been designed with dimensions of 8½ by 11 inches, and will thus fit a conveniently sized clip-board when being entered up by the gager. It can also be punched for filing in a post binder.

The information from the daily tank gage report will be entered in one of the following three records:

Process cost ledger, Form 23*b* (page 215),
Sales journal, Form 24 (page 216),
Voucher record, Form 26 (page 218).

Quantities Shown by the Process Cost Ledger.—This record is to be kept by processes, one sheet being allotted to each. The crude oil or unfinished product pumped to the process, as shown by the daily gage report, should be posted in the space provided therefor; the process output for the 24-hour period will also be reflected in the gage report and should be posted to the properly captioned column. The total quantities will be carried to the front side of the sheet (Form 23*a*) monthly.

Where a tank of crude oil, unfinished product, or finished product remains inactive for some little time, losses from evaporation and seepage will become apparent in the gage reports. In order to record these, a special *Evaporation loss* sheet should be opened on Form 23*b*, and monthly adjustment can be made by journal voucher.

This form will also be found quite convenient for recording oil used for fuel purposes, a column being used therefor under the process in which the oil is burned. The information, of course, will be secured from the daily tank gage report, and proper charge can be made by monthly journal voucher.

Quantities Shown by Sales Journal.—All sales, either to outsiders or to the company's marketing department, will be recorded in the sales journal. Invoices should be made in triplicate, and should be typewritten. The original (vendee's copy) and duplicate (accounting department's copy) will remain in the sales office awaiting the return of the third copy from the loading racks or shipping room. The loading rack foreman should enter on the third copy the tank car number in which shipment was made, route, date, gravity, temperature, and gallonage. Where the company follows the practice of sampling each car shipped, the invoice should be forwarded to the laboratory together with the sample withdrawn; information concerning the various distillation, fire, flash, etc. tests will be entered on the third copy of the invoice, by the testing chemist. The copy will then be returned to the sales office, after which the other two copies may be completed.

The gallonages shown by the invoices for each day's shipments, should be agreed with daily gaged deliveries, as obtained and entered from the daily gage reports. Overages and shortages may be adjusted by journal entry at the end of each month; it is needless to add that any large differences that show up, should be investigated.

Quantities Shown by Voucher Record.—The company's purchases of crude oil, as well as of finished or unfinished products, will be passed through the voucher record. Gallonages paid for should be agreed with the daily intake from outside sources, as disclosed by the daily tank gage. Any overages or shortages may be adjusted by journal voucher at the end of the month.

Idle Plant Expense.—In the event that the plant is not operating at normal capacity, certain fixed charges, as well as a number of the regular operating and maintenance expenses, will be attributable to what may be termed idle plant expense. If the company so desires, an account may be raised for expenses of this class, in order to determine them separately, but the practice of omitting such expenses from costs is strongly deprecated. For, after all, there is but one purpose in determining costs, and that is to ascertain what it is actually costing the company to manufacture its production. If costs are to be modified by omissions of actual expense, and standardized by such means as the recently much discussed *normal burden*, it would appear quite a futile and objectless procedure to calculate costs at all, it being much easier simply to adopt standard costs.

There is one occasion when idle plant expense may be permissible, and that is when production is so far below capacity as to cause the cost of production to exceed its market value. Inventories should not, in any event, be priced at more than selling price, less estimated marketing costs.

CHAPTER XVII

COST FINDING

The selection of a suitable method for finding the refined costs of the products of a crude petroleum refinery, at first thought, seems to lie between the two methods of cost finding which are common to all industry, the job method and the process method.

Job Method.—The job method, also variously termed order method, specific order method, and job order method, is the first to present itself, since any concept of production is based upon the idea of production for a specific purpose. Or, stated in another way, when we think of production, we think immediately also of the need which gave rise thereto, of the customers' or stock orders, each representing an individual requirement.

Upon closer examination, and from practical experience, it develops that a number of difficult features prevent the job method from lending itself to our purpose. In the first place we find that, although production in a refinery *does* have its inception in specific requirements, yet the actual operating procedure is such that specific orders must lose their identity in the course of processing. Thus we have a case which violates the first rule of the job method, that *the identity of the orders must be preserved throughout the process of manufacture.*

Even in those plants which adhere strictly to the batch method of refining as far as the fire-stilling is concerned, we find that there exists the objection of lost identity in the further processing and reprocessing. Where the fuel oil and other cuts are subjected to destructive distillation in a cracking unit, another complication is introduced, since the resultant product is broken down into additional products.

It would appear, therefore, that we shall be obliged to abandon any idea of employing the job method in finding refinery costs.

Process Method.—As the procedure of reduction and separation by means of refining is essentially one of processes, each process a distinct operation within itself, and in many cases applied; to certain products only, the process method of cost finding would seem to have a great many points in its favor.

In order that there may be no misconception of the term, let us first explain the process method; it may also be well to examine into its applicability to the case in hand, before proceeding.

In its commonly accepted sense, the process method involves three steps, each of which must be carried out in the manner best suited to the particular case with which the accountant is dealing:

Step 1.—To record, in a systematic and accurate manner, the physical production from each process or production center of the plant, and from the plant as a whole.

Step 2.—To record, carefully and accurately, the operating and maintenance expenses of the plant, grouping these expenses where possible according to processes, and further allocating to each process, upon some selected basis, such expenses as are of a general nature and applicability.

Step 3.—To apply, scientifically but practically, the total expense of each process to the production from the process, thus determining the cost of production in each case and, finally, of the production from the plant as a whole.

Now, in considering the special points which arise in an oil refinery, we find that, not only have we the problem of several products from several processes, but also that we have several products from one raw material. In other words we are obliged to find a means for spreading to products not only our *manufacturing costs,* but our *raw material* as well.

Here then, the so-called *point method* suggests itself, leaving out of consideration for the present the by-product method of cost finding. The fact that each of the products has a different value in the world's markets, and requires in its manufacture both a different constituent element of the crude oil and a different operating process, indicates that in allocating to such products the cost of their production, not only the quantities produced, but the *values* of such quantities, must be considered.

Material (Crude Oil) Cost.—Let us discuss first the subject of material. The fact that the gasoline content of crude petroleum is usually the main objective of refiners, and that the posted market price for crude oil is graduated according to its specific gravity, indicates that the gasoline extracted carries with it a portion of the cost of the crude oil entirely disproportionate to the *quantity* of gasoline recovered. The same is true in varying degree in the case of kerosene, lubricating oil stock, and the other products; for as each successive product is removed, the residuum sustains a decrease in value which is attributable to two factors:

1. Decrease in quantity.
2. Lower value of remaining constituent elements.

From the foregoing facts it would appear that we have reason for the general statement that the cost of the crude oil should be allocated to each of its constituent elements in the proportion that the product of the quantity and value of such commodity bears to the similar total for all the constituent commodities. This may be illustrated as follows:

Commodity	Assumed production, gallons	Market price, cents	Total value	% of each to total
Gasoline....................	100	10	$10.00	80
Kerosene....................	50	5	2.50	20
	150		$12.50	100

Eighty per cent of the cost of the crude oil used in the production of the commodities above shown (the products shown being assumed to be the complete marketable content of the crude oil) should, under this method, be considered as representing the material cost of the gasoline, while twenty per cent of such crude oil cost must be considered as applicable to the kerosene produced.

A further effect of this procedure is to cause each of the products obtained to absorb a share of the evaporation loss from refining, in proportion to the marketable value of good production. This result is substantiated by the facts; for the production of gasoline, the product with the highest value and the one which will therefore bear the highest share per gallon of the evaporation loss, is responsible in processing for a large part of the loss.

Manufacturing (Refining) Cost.—The *value* of production would seem to have very little to do with the method of distributing the cost of refining amongst the several products. However, examination of specific cases will show that the failure to consider values, in the case of (say) crude oil with a low gasoline content, may distort results to such an extent that they are either valueless or at any rate dangerously misleading. Assume a crude oil with a 10 per cent gasoline recovery, and then determine costs, first by applying refining expenses on the basis of quantities only, and afterward by including the value factor; the value basis of allocating the crude oil cost is used in both cases:

Allocation of Crude Cost on Value Basis

Commodity	Gallons	Market value		% to total	Amount
		Cents per gallon	Total		
Crude consumed	4,200	..	....	..	$50.00
Produced:					
Gasoline	400	10	$ 40.00	36	$18.00
Fuel oil	3,600	2	72.00	64	32.00
Loss	200				
	4,200		$112.00		$50.00

Allocation of Refining Cost on Quantity Basis

Commodity	Crude cost	Refining cost		Together	
		% to total	Amount	Total	Cents per gallon
Gasoline	$18.00	10	$ 5.00	$ 23.00	5.75
Fuel oil	32.00	90	45.00	77.00	2.13
	$50.00		$50.00	$100.00	

Allocation of Refining Cost on Value Basis

Commodity	Crude cost	Refining cost		Together	
		% to total	Amount	Total	Cents per gallon
Gasoline	$18.00	36	$18.00	$ 36.00	9.00
Fuel oil	32.00	64	32.00	64.00	1.76
	$50.00		$50.00	$100.00	

It will be noted that the cost of producing fuel oil, as computed under the quantity basis, is in excess of the market value of the production, and that gasoline shows a margin of 4.25 cents per gallon gross profit! This is somewhat absurd for, although it is possible to imagine refining the oil for its gasoline content only, and valuing the fuel oil at the best price obtainable, we cannot deny that any amount by which the recorded cost of producing fuel oil *exceeds* its value, is purely and simply an increase in the cost of gasoline. The refiner certainly would not continue to produce fuel oil at a loss, were he not obliged to do so in the course of obtaining the gasoline. The case drawn is perhaps an extreme one, yet it serves to illustrate the principle involved, that a refinery is operated as a single unit and any profit realized is the result of marketing all the products.

Methods in General Use.—There are a number of methods in general use for finding refinery costs. Some are good, others are indifferent, while the less said about the remaining ones the better; as a matter of fact the greater number of those to which the latter remark is applicable hardly deserve the appelation of "method" at all, for like the immortal Topsy, *they just growed.*

In their practical experience, as well as in their special research work along these lines, the authors have found but two methods which recommend themselves from the points of view both of theoretical accuracy and of practicability. It is proposed to explain both methods, and it is believed that either may be used with satisfactory results; of course, amplifications or modifications may be made wherever existing circumstances warrant changes. Briefly, the two methods are as follows:

Weighted Selling Ratio Method.—Under this method the production for the period is costed, as to both material and treating expense, by means of allocating to each product a ratable portion of these two elements of cost; the basis for such allocation is the ratio of the value of each product to the total value of all products. The treating expense, kept separately by processes and including both labor and expense, is apportioned only to such products as pass through the particular process. The basic principle under this method is simply a derivation of the point method of cost finding used in several industries, but the practice of weighting the basis for allocating the costs, by averaging market values, is new. It will be found to possess the advantage of eliminating from the factors all temporary market fluctuations, as well as expediting the calculation of the production costs each month. Complete calculations of costs for one month under this method are shown in the example on pages 182 to 195.

Market-to-cost Method.—This plan has several features that recommend it, and chief among these is its simplicity. The principle involved is best illustrated by the following age-old bookkeeping axiom: Opening inventory at cost + Production cost = Cost of goods sold + Closing inventory.

If we have the first two of these figures at cost, and the last two at market values, the difference will represent the amount by which the market value of the items involved exceeds the actual cost thereof. Now, having reduced this difference to a percentage, we have but to apply the percentage to each of the last two figures in order to bring them to actual cost. Of course, this method serves only to reduce the closing inventory to actual cost *in toto,* thus furnishing a means of calculating profit or loss for the period. It will not disclose the separate costs of different products, and is useless where product cost statistics are held to be indispensable. In point of fact, the chief interest of many refiners operating on a large scale is not so much *product cost* as it is *production cost.* In other words the refiner is most interasted in knowing how much the operation of the plant *as a whole* has cost during the period, subdivided as to processes; such figures may be compared, period with period, and serve as an excellent index of refinery efficiency.

Other Methods.—The two principal other methods for determining refinery costs are those which we may designate as *quantities method* and *by-product method.*

Under the first of these two methods, refinery expenses are subdivided as to processes in the manner before indicated. The cost of the crude oil entering into the several products is spread to such products in the ratio which the market value of each bears to the total market value of all, while refining expense under each process is allocated to products on the basis of quantities treated. As was shown earlier in this chapter, this method may produce results which are grossly misleading, and for this reason is not recommended.

The by-product method has in its favor the fact that it may be so used as to simplify the cost sheets appreciably. Its underlying theory is that the refiner has as objectives certain selected products, say gasoline, kerosene and lubricants, and that any incidental commodities are by-products which may be eliminated from the calculations at arbitrary prices.

EXAMPLE OF COST FINDING UNDER THE WEIGHTED SELLING RATIO METHOD

This method of cost finding has the advantage of determining for every product a cost which will allow for a reasonable profit when disposition is made thereof. Moreover, it is not open to the objections common to most systems, which either arrive at a cost of some individual product which is entirely disproportionate to its selling value, or endeavor to allocate to some one supposed *main product* the entire cost of the process, treating any additional products obtained as by-products, notwithstanding the fact that such by-products may have a considerable value on the open market. In the system here presented, *every product is treated as a main product.*

As previously pointed out, there seems no well-sustained reason for dividing the products and expenses entering into each process on different bases. Under the weighted selling ratio method the process expenses, including both the crude oil or unfinished product used and the cost of operation, are divided on the basis of the marketable value of each product. In order, however, to avoid reflecting in costs any temporary fluctations of the relative market prices of various products, the market prices for the preceding 6 months are averaged in calculating the costs of the current month.

The present method of cost finding is divided into three distinct computations:

1. Calculating the costs of the current month, based on market prices for the preceding 6 months.
2. Arriving at the month's ultimate yield percentages (ignoring the products in process), together with the volumetric loss on operations.
3. Computing market values of unfinished intermediate products by deducting from the market values of the constituent products the known cost of finishing; calculating the estimated gross profit on operations for the month.

Methods of recording daily tank gages (Form 21), and of posting the gallonages to the reverse side of the process cost ledger sheets (Form 23*b*), as well as the division of expenses and service accounts and the entries to be made to the process expense analysis (Form 22), have already been dealt with in Chap. XVI. At this point the reader should refer to the Process Cost Ledger itself (Form 23*a*, page 214), which has been designed for use with the method under discussion, and follow out the method of recording costs, step by step, as set out in the following pages.

At the outset it should be stated that the system suggested is less complicated than the average system in use; that it should be possible to calculate the costs for a particular month in a single day, after all postings have been completed; and that the ultimate yield and market-price statements need not be completed before the books are closed, but may be left over for several days if necessary.

In working out the following problem, we are taking as a basis the refinery graphically portrayed in Fig. 7 (page 150), although another refinery with different processes could have been used equally well. For the sake of convenience, operations have been divided into eight main processes. These processes are as follows, and are so arranged that no product is carried back into a previous process:

Process No.	Nature of process	Product consumed	Product produced
I.	Crude still	Crude oil	Crude naphtha Kerosene distillate Gas oil Wax distillate Tar residue
II.	Agitatro No. 1 and steam still	Crude naphtha	Gasoline Finished naphtha Wax distillate
III.	Tar still	Tar residue	Kerosene distillate Wax distillate Coke
IV.	Filter presses	Wax distillate	Slack wax Pressed distillate
V.	Sweaters, Filter No. 3 and moulding	Slack wax	Moulded wax
VI.	Reducing still	Pressed distillate	Unfiltered lubricating oils Gas oil
VII.	Filters Nos. 1 and 2	Unfiltered lub. oils	Filtered oils
VIII.	Agitator No. 2 and bleacher tank	Kerosene distillate	Kerosene

The process expenses, excluding the product consumed, as recorded in the Process Expense Analysis for, say, the month of July, 1924, are as follows:

Process I	$ 3,400
Process II	1,800
Process III	300
Process IV	2,000
Process V	400
Process VI	400
Process VII	1,400
Process VIII	300
	$10,000

Stocks of finished and unfinished products at June 30, 1924, as recorded on the books, are as follows:

Commodity	Gallons	Price, cents	Amount
Unfinished stocks:			
Crude oil	2,000,000	5.0	$100,000
Crude naphtha	150,000	6.4	9,600
Kerosene distillate	50,000	5.3	2,650
Pressed distillate	125,000	5.9	7,375
Wax distillate	75,000	5.5	4,125
Slack wax	25,000	12.6	3,150
Tar residue	10,000	1.8	180
Unfiltered lubricating oils	4,000	9.1	364
Finished stocks:			
Gasoline	300,000	9.8	29,400
Finished naphtha	15,000	6.8	1,020
Kerosene	250,000	5.1	12,750
Gas oil	150,000	3.0	4,500
Filtered oils	50,000	10.5	5,250
Moulded wax	25,000	13.5	3,375
Coke	20,000	.7	140

Market prices of finished and unfinished products for the 6 months preceding the operating month, in cents per gallon, together with the average for the 6 months, are as follows:

Commodity	January	February	March	April	May	June	Average
Finished stocks (actual market prices):							
Gasoline	13.5	13.5	13.0	12.5	12.5	13.0	13.00
Finished naphtha	12.0	11.5	11.5	11.0	9.0	9.0	10.67
Kerosene	10.0	9.0	9.0	8.5	7.0	7.0	8.42
Gas oil	3.4	3.6	4.5	5.0	4.0	4.0	4.08
Filtered oils	18.0	18.0	17.0	17.0	16.0	14.0	16.67
Moulded wax	26.0	24.0	23.0	20.0	18.0	18.0	21.50
Coke	1.5	1.5	1.5	1.0	1.0	1.0	1.25
Unfinished products (calculated in accordance with computation 3, page 182):							
Crude naphtha	11.5	10.9	10.8	10.4	8.6	8.5	10.12
Kerosene distillate	9.8	8.7	8.8	8.4	6.6	6.8	8.18
Pressed distillate	9.9	9.8	9.7	10.0	9.2	7.9	9.42
Wax distillate	10.5	10.0	9.5	8.3	7.7	7.3	8.88
Slack wax	25.2	23.2	22.0	18.9	17.0	16.8	20.52
Tar residue	3.4	3.0	2.8	2.7	2.5	2.4	2.80
Unfiltered lubricating oils	16.5	16.5	15.4	15.4	14.6	12.2	15.10

With the information concerning gallonages consumed and produced by each process, recorded on the back of the process cost ledger sheets, we have now all the data necessary for calculating our costs for July, 1924; these will be as follows, as recorded on the right-hand side of the process cost ledger sheets:

Description	Gallonage		Average selling price previous 6 months	Cost factors		Amount	Price per gallon, cents
	Quantity	% to total		Product of 2 previous columns	% to total		
Process I.							
Consumed:							
Crude oil, from stock	1,000,000	...	.....	....	......	$50,000.00	5.0
Expenses		...	.....	....	......	3,400.00	.34
Total process cost—showing cost per gallon consumed						$53,400.00	5.34
Produced:							
Crude naphtha	300,000	30	10.12	30,360	40.91	$21,845.94	7.28
Kerosene distillate	180,000	18	8.18	14,724	19.84	10,594.56	5.89
Gas oil	210,000	21	4.08	8,568	11.55	6,167.70	2.94
Wax distillate	200,000	20	8.88	17,760	23.93	12,778.62	6.39
Tar residue	100,000	10	2.80	2,800	3.77	2,013.18	2.01
Loss	10,000	1					
	1,000,000	100		74,212	100.00	$53,400.00	
Process II.							
Consumed:							
Crude naphtha:							
From stock	150,000	...	.....	....	......	$ 9,600.00	6.4
From Process I	200,000	...	.....	....	......	14,560.00	7.28
Total consumed	350,000	...	.....	....	......	$24,160.00	6.90
Expenses		...	.....	....	......	1,800.00	.52
Total process cost—showing cost per gallon consumed						$25,960.00	7.42
Produced:							
Gasoline	262,500	75	13.00	97,500	80.48	$20,892.61	7.96
Finished naphtha	63,000	18	10.67	19,206	15.85	4,114.66	6.53
Wax distillate	17,500	5	8.88	4,440	3.67	952.73	5.44
Loss	7,000	2					
	350,000	100		121,146	100.00	$25,960.00	
Process III.							
Consumed:							
Tar residue:							
From stock	10,000	...	.....	....	......	$ 180.00	1.8
From Process I	90,000	...	.....	....	......	1,809.00	2.01
Total consumed	100,000	...	.....	....	......	$ 1,989.00	1.99
Expenses		...	.....	....	......	300.00	.30
Total process cost—showing cost per gallon consumed						$ 2,289.00	2.29
Produced:							
Kerosene distillate	10,000	10	8.18	8,180	28.21	$ 645.73	6.46
Wax distillate	15,000	15	8.88	13,320	45.93	1,051.34	7.01
Coke	60,000	60	1.25	7,500	25.86	591.93	.99
Loss	15,000	15					
	100,000	100		29,000	100.00	$ 2,289.00	
Process IV.							
Consumed:							
Wax distillate:							
From stock	75,000	...	.....	....	......	$ 4,125.00	5.5
From Process I	92,500	...	.....	....	......	5,910.75	6.39
From Process II	17,500	...	.....	....	......	952.73	5.44
From Process III	15,000	...	.....	....	......	1,051.34	7.01
Total consumed	200,000	...	.....	....	......	$12,039.82	6.02
Expenses		...	.....	....	......	2,000.00	1.00
Total process cost—showing cost per gallon consumed						$14,039.82	7.02
Produced:							
Slack wax	48,000	24	20.52	49,248	41.07	$ 5,766.15	12.01
Pressed distillate	150,000	75	9.42	70,650	58.93	8,273.67	5.52
Loss	2,000	1					
	200,000	100		119.898	100.00	$14,039.82	

Description	Gallonage		Average selling price previous 6 months	Cost factors		Amount	Price per gallon, cents
	Quantity	% to total		Product of 2 previous columns	% to total		
Process V.							
Consumed:							
Slack wax:							
From stock	25,000	...	...	...	...	$ 3,150.00	12.6
From Process IV	25,000	...	...	...	...	3,002.50	12.01
Total consumed	50,000	...	...	...	...	$ 6,152.50	12.31
Expenses	...	...	...	...	...	400.00	.80
Total process cost—showing cost per gallon consumed						$ 6,552.50	13.11
Produced:							
Moulded wax	48,500	97	21.50	...	100.00	$ 6,552.50	13.45
Loss	1,500	3					
	50,000	100			100.00	$ 6,552.50	
Process VI.							
Consumed:							
Pressed distillate:							
From stock	125,000	...	...	...	...	$ 7,375.00	5.9
From Process IV	75,000	...	...	...	...	4,140.00	5.52
Total consumed	200,000	...	...	...	...	$11,515.00	5.76
Expenses	...	...	...	...	...	400.00	.20
Total process cost—showing cost per gallon consumed						$11,915.00	5.96
Produced:							
Unfiltered lubricating oils	104,000	52	15.10	78,520	81.05	$ 9,657.11	9.29
Gas oil	90,000	45	4.08	18,360	18.95	2,257.89	2.51
Loss	6,000	3					
	200,000	100		96,880	100.00	$11,915.00	
Process VII.							
Consumed:							
Unfiltered lubricating oils:							
From stock	4,000	...	...	...	...	$ 364.00	9.1
From Process VI	96,000	...	...	...	...	8,918.40	9.29
Total consumed	100,000	...	...	...	...	$ 9,282.40	9.28
Expenses	...	...	...	...	...	1,400.00	1.40
Total process cost—showing cost per gallon consumed						$10,682.40	10.68
Produced:							
Filtered oils	95,000	95	16.67	...	100.00	$10,682.40	11.24
Loss	5,000	5					
	100,000	100			100.00	$10,682.40	
Process VIII.							
Consumed:							
Kerosene distillate:							
From stock	50,000	...	...	...	...	$ 2,650.00	5.3
From Process I	140,000	...	...	...	...	8,246.00	5.89
From Process III	10,000	...	...	...	...	645.73	6.46
Total consumed	200,000	...	...	...	...	$11,541.73	5.77
Expenses	...	...	...	...	...	300.00	.15
Total process cost—showing cost per gallon consumed						$11,841.73	5.92
Produced:							
Kerosene	198,000	99	8.42	...	100.00	$11,841.73	5.98
Loss	2,000	1					
	200,000	100			100.00	$11,841.73	

From a study of the cost sheets, the procedure followed in making the calculations will probably be evident, but the following detailed explanation of Process I, taken in the order in which the entries will be made, may be of assistance in clearing up any doubtful points:

Item	How Obtained
1. Crude oil consumed	Summary of gage reports, as shown on the reverse side of the process cost ledger sheet kept for Process I
2. Crude oil price	Ledger price at June 30, 1924
3. Total cost of crude	Product of items 1 and 2
4. Expenses	Process expense analysis totals
5. Expense price per gallon	\$3,400 divided by 1,000,000 gallons consumed
6. Quantities produced	Same source as item 1, above
7. Gallonage—per cent to total	Actual computation
8. Average selling price previous six months	Per record on file, as previously listed herein
9. Product of two previous columns	30 multiplied by 10.12, etc. (Note.—Five figures in the product will give sufficiently accurate results.)[1]
10. Cost factors—per cent to total	Actual computation
11. Total costs	Percentages in previous column applied to total process cost
12. Price per gallon, cents	Total cost divided by gallonage produced. (Note that these prices are carried into any subsequent process, *after the stock at the beginning of the month has been exhausted.*)

We are now in a position to prepare our journal entry for posting to the general ledger, but a summary of stocks of finished and unfinished products for the month might first be prepared, in some such form as shown on pages 190 and 191. For the purpose of clarity, one line has been used under each unfinished product for each price, bringing out the fact that the opening stocks are considered to have been used first, and the later process stocks next, thus leaving the new inventory valued at the lowest cost of manufacture.

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[1] Many refineries carry out their cost calculations to several places of decimals but it is doubtful whether the results obtained are at all commensurate with the labor involved. It is suggested that in most cases four, or at most five, significant figures will give sufficiently accurate results.

Theoretically, production of a given product from two different processes should be priced at the weighted average, but since this procedure would lead to complications in making product transfers between processes, the simpler and more practical method is to charge out the whole of the production from the later of the two contributing processes, before making any charge from the production of the earlier process.

The following summary does not, of course, include purchases and sales for the month, and the prices of finished stocks and crude oil stocks at the close of the month are not, therefore, shown. The necessary journal entry to record the figures is obvious, but it may be mentioned that all process quantity losses have already been absorbed in the production costs, and that no further entry in this connection is necessary.

As previously suggested, the calculation of ultimate yield, and the building up of market prices of all products, together with the estimating of the gross profit on operations, can be left till after the books are closed for the month.

The ultimate yield is obtained by applying the known production percentages from each process to a given quantity of crude oil which is assumed to have been entirely refined; in other words, increases or decreases in stocks of unfinished products are ignored. In figuring the ultimate yield, it is a good plan to commence with, say, 10,000 or 100,000 gallons of crude, so that the total quantities of the resulting finished products will show the actual percentages produced, without recalculation.

In the statement on pages 192 to 194 the finished products are designated with an asterisk, and it will be seen that:

1. The actual quantity of *unfinished* product resulting from any process is carried on to the next process (*e.g.*, 1,800 gallons of kerosene distillate produced in Process I and 100 gallons in Process III, are carried on to Process VIII as 1,900 gallons).
2. The actual quantity of *finished* product is carried to the summary at the bottom of the page (*e.g.*, 2,100 gallons of gas oil produced in Process I and 776 gallons produced in Process VI, are carried to summary as 2,876, that is, 28.76 per cent).

In arriving at the market prices of the ultimate yield, the following market prices for finished products (in cents per gallon) during July, 1924, have been assumed (see page 192).

SUMMARY OF PRODUCT STOCKS

Product	Stocks at beginning			Prod	
	Gallons	Price, cents	Amount	Process	Gallons
Finished:					
Gasoline	300,000	9.8	$ 29,400.00	II	262,500
Finished naphtha	15,000	6.8	1,020.00	II	63,000
Kerosene	250,000	5.1	12,750.00	VIII	198,000
Gas oil	150,000	3.0	4,500.00	I VI	210,000 90,000
Filtered oils	50,000	10.5	5,250.00	VII	95,000
Moulded wax	25,000	13.5	3,375.00	V	48,500
Coke	20,000	.7	140.00	III	60,000
Unfinished:					
Crude naphtha	150,000	6.4	9,600.00	....	....
				I	300,000
Kerosene distillate	50,000	5.3	2,650.00	....	....
				I	180,000
				III	10,000
Pressed distillate	125,000	5.9	7,375.00	....	....
				IV	150,000
Wax distillate	75,000	5.5	4,125.00	....	....
				I	200,000
				II	17,500
				III	15,000
Slack wax	25,000	12.6	3,150.00	....	....
				IV	48,000
Tar residue	10,000	1.8	180.00	....	....
				I	100,000
Unfiltered lubricating oils	4,000	9.1	364.00	....	....
				VI	104,000
Crude oil	2,000,000	5.0	100,000.00	....	....
	3,249,000	....	$183,879.00	....	2,151,500
Expenses for month	....	....	....	....	....
Gallonage losses for all processes	....	....	....	....	48,500
					2,200,000

FOR THE MONTH OF JULY, 1924

uced		Consumed				Stocks at end		
Price, cents	Amount	Process	Gallons	Price, cents	Amount	Gallons	Price, cents	Amount
7.96	$ 20,892.61	....	....	......	....	562,500	......	$ 50,292.61
6.53	4,114.66	....	....	......	....	78,000	......	5,134.66
5.98	11,841.73	....	....	......	....	448,000	......	24,591.73
2.94	6,167.70	...	....	......	....	450,000	......	12,925.59
2.51	2,257.89							
11.24	10,682.40	....	....	......	....	145,000	......	15,932.40
13.45	6,552.50	....	....	......	....	73,500	......	9,927.50
.99	591.93	....	....	......	....	80,000	......	731.93
....	....	II	150,000	6.4	$ 9,600.00			
7.28	21,845.94	II	200,000	7.28	14,560.00	100,000	7.28	7,285.94
....	....	VIII	50,000	5.3	2,650.00			
5.89	10,594.56	VIII	140,000	5.89	8,246.00	40,000	5.89	2,348.56
6.46	645.73	VIII	10,000	6.46	645.73			
....	....	VI	125,000	5.9	7,375.00			
5.52	8,273.67	VI	75,000	5.52	4,140.00	75,000	5.52	4,133.67
....	....	IV	75,000	5.5	4,125.00			
6.39	12,778.62	IV	92,500	6.39	5,910.75	107,500	6.39	6,867.87
5.44	952.73	IV	17,500	5.44	952.73			
7.01	1,051.34	IV	15,000	7.01	1,051.34			
....	....	V	25,000	12.6	3,150.00			
12.01	5,766.15	V	25,000	12.01	3,002.50	23,000	12.01	2,763.65
....	....	III	10,000	1.8	180.00			
2.01	2,013.18	III	90,000	2.01	1,809.00	10,000	2.01	204.18
....	....	VII	4,000	9.1	364.00			
9.29	9,657.11	VII	96,000	9.29	8,918.40	8,000	9.29	738.71
....	....	I	1,000,000	5.0	50,000.00	1,000,000	......	50,000.00
....	$136,680.45	....	2,200,000	.....	$126,680.45	3,200,500	....	$193,879.00
....	....	....	....	......	10,000.00			
....	$136,680.45	....	2,200,000	......	$136,680.45			

	Cents per Gallon
Gasoline	12.3
Finished naphtha	10.2
Kerosene	8.1
Gas oil	4.0
Filtered oils	15.7
Moulded wax	20.5
Coke	1.0

These prices have been entered in the statement, opposite the finished products asterisked, and the total costs extended. The next step is to enter the expenses per gallon, at the prices actually ascertained for the month, and to extend the amounts for each process.

The missing figures can then be calculated, step by step, starting with the last process first and gradually working back to the beginning. Taking Process VIII, for example:

> We know that the market price of kerosene is 8.1 cents per gallon, and the total value of 1,881 gallons is, therefore, $152.36. We also know that the expenses of the process were $2.85 (cost of process .15 cents per gallon from monthly cost sheet, multiplied by 1,900 gallons). The market value of kerosene distillate is, therefore, $149.51 ($152.36 less $2.85) which results in a price of 7.87 cents per gallon. The 1,900 gallons is then split up into 1,800 gallons produced in Process I and 100 gallons in Process III, the same price being used in each case, since we are now dealing with *market values* and not with *costs*.

The calculations are made in a similar manner for each process, and the whole statement will finally appear as follows:

Description	Ultimate yield, July, 1924		From or to Process number	Market prices of ultimate yield	
	Gallonage			Amount	Per gallon, cents
	% to total	Quantity			
Process I.					
Consumed:					
Crude oil	..	10,000	....	$749.78	7.50
Expenses	..	......	....	34.00	.34
Produced:					
Crude naphtha	30	3,000	II	$331.29	11.04
Kerosene distillate	18	1,800	VIII	141.64	7.87
Gas oil	21	2,100	*	84.00	4.0
Wax distillate	20	2,000	IV	200.92	10.04
Tar residue	10	1,000	III	25.93	2.59
Loss	1	100			
		10,000		$783.78	

Description	Ultimate yield, July, 1924		From or to Process number	Market prices of ultimate yield	
	Gallonage			Amount	Per gallon, cents
	% to total	Quantity			
Process II.					
Consumed:					
Crude naphtha	..	3,000	I	$331.29	11.04
Expenses	..	......	....	15.60	.52
Produced:					
Gasoline	75	2,250	*	$276.75	12.3
Finished naphtha	18	540	*	55.08	10.2
Wax distillate	5	150	IV	15.06	10.04
Loss	2	60			
		3,000		$346.89	
Process III.					
Consumed:					
Tar residue	..	1,000	I	$ 25.93	2.59
Expenses	..	......	....	3.00	.30
Produced:					
Kerosene distillate	10	100	VIII	$ 7.87	7.87
Wax distillate	15	150	IV	15.06	10.04
Coke	60	600	*	6.00	1.0
Loss	15	150			
		1,000		$ 28.93	
Process IV.					
Consumed:					
Wax distillate	..	2,300	I, II, III	$231.04	10.04
Expenses	..	......	....	23.00	1.00
Produced:					
Slack wax	24	552	V	$105.25	19.07
Pressed distillate	75	1,725	VI	148.79	8.63
Loss	1	23			
		2,300		$254.04	
Process V.					
Consumed:					
Slack wax	..	552	IV	$105.25	19.07
Expenses	..	......	....	4.42	.80
Produced:					
Moulded wax	97	535	*	$109.67	20.5
Loss	3	17			
		552		$109.67	
Process VI.					
Consumed:					
Pressed distillate	..	1,725	IV	$148.79	8.63
Expenses	..	......	....	3.45	.20
Produced:					
Unfiltered lubricating oils	52	897	VII	$121.20	13.51
Gas oil	45	776	*	31.04	4.0
Loss	3	52			
		1,725		$152.24	
Process VII.					
Consumed:					
Unfiltered lubricating oils	..	897	VI	$121.20	13.51
Expenses	..	......	....	12.56	1.40
Produced:					
Filtered oils	95	852	*	$133.76	15.7
Loss	5	45			
		897		$133.76	

Description	Ultimate yield, July, 1924		From or to Process number	Market prices of ultimate yield	
	Gallonage				
	% to total	Quantity		Amount	Per gallon, cents
Process VIII.					
Consumed:					
Kerosene distillate	..	1,900	I, III	$149.51	7.87
Expenses	..	......	....	2.85	.15
Produced:					
Kerosene	99	1,881	*	$152.36	8.1
Loss	1	19			
		1,900		$152.36	
Summary of ultimate yield:		Per cent			
Gasoline	..	22.50			
Finished naphtha	..	5.40			
Kerosene	..	18.81			
Gas oil	..	28.76			
Filtered oils	..	8.52			
Moulded wax	..	5.35			
Coke	..	6.00			
		95.34			
Loss	..	4.66			
		100.00			

It will be noted that the summary of the ultimate yield at the bottom of the statement, proves the accuracy of the calculations throughout; the following proof of the correctness of the market-price computations will be of interest:

Crude consumed		$749.78
Expenses:		
Process I	$ 34.00	
Process II	15.60	
Process III	3.00	
Process IV	23.00	
Process V	4.42	
Process VI	3.45	
Process VII	12.56	
Process VIII	2.85	98.88
		$848.66
Finished products produced:		
I Gas oil	$ 84.00	
II Gasoline	276.75	
II Finished naphtha	55.08	
III Coke	6.00	
V Moulded wax	109.67	
VI Gas oil	31.04	
VII Filtered oils	133.76	
VIII Kerosene	152.36	$848.66

The final result shows an estimated profit on operations of $249.78 (from our hypothetical 10,000 gallons of crude consumed) made up of

Market value of products produced		$848.66
Cost of crude oil—10,000 gallons at 5 cents	$500.00	
Expenses of operations	98.88	598.88
Estimated gross profit		$249.78

The percentage of gross profit can be based on sales or cost of sales, according to the company's policy in this respect.

In calculating August costs the new market values for July will be added on to the schedule of market values by months, the figures for January struck out, and a new average obtained.

CHAPTER XVIII

SALES AND OTHER EARNINGS

The problem of marketing is one of the most important with which the refiner is called upon to deal. Not only is he obliged to meet, to a certain extent, the competitive prices of the inferior products of small and often unscrupulous refiners, but he must also be resourceful enough to survive the price-slashing between the larger companies.[1] This requires sound knowledge and broad experience, as well as capital sufficient to carry over the rough places.

Sales of Products.—In the refinery contemplated by the present volume, the major portion of the company's sales are made through a separate marketing organization. The latter will sell both wholesale, by tank car and tank steamer, and retail, through conveniently situated service stations (see Part IV). However, certain miscellaneous sales will be made by the refinery, f.o.b. the plant, and in buyers' tank cars.

Invoicing Sales.—All sales, whether to outsiders or to the marketing division, should be invoiced. As orders are received, the invoices should be made out, say, in triplicate; the number of required copies will vary in different organizations. The original, which is the buyer's copy, should remain in the sales department together with the second, or accounting department's copy; the triplicate will be sent as an order to the loading racks or shipping room, according to the commodity. Here it will be filled in with sufficient information to permit of the completion of the first and second copies, and then returned to the sales department.

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[1] Price wars between the large companies have been frequent of late years, much to the benefit and delight of the motoring public. A notable example occurred during July, August, and September of 1923, when gasoline could be purchased at 7 and 8 cents per gallon in many of the middle-western and western cities. It may be mentioned that a calculation made at the time, based upon the costs shown by the records of one of the warring companies, revealed the fact that the gasoline being sold at 8 cents actually cost 10 cents per gallon to produce, and an additional 3 cents to market.

Sales Journal (*Form* 24, page 216).—A sheet of the sales journal should be opened for each commodity, and invoices posted therein. Any allowance which the company is obliged to make in order to equalize the freight charges, will be shown on the face of the invoice and deducted from the total amount thereof. Columns are provided in the sales journal for amount, freight allowance, and net charge. Freight allowed is preferably treated as a deduction from sales in the income statement, although there is no serious objection to stating it as a selling expense.

Information concerning routing, tank-car number, and gallonage, should be as carefully entered as the amounts. It must be remembered that quantities invoiced are to be agreed with deliveries from storage.

In cases where the company handles both refined and natural (casinghead) gasoline, separate sales journal sheets should be used for each.[1]

Debit and Credit Memo Register (*Form* 25, page 217).—On account of the number and variety of debit and credit memorandums which a refinery must issue, it is better to provide a separate record for such memorandums. Debit and credit memos should bear separate series of numbers and, needless to say, should always be approved by some one in authority. Memos will be of the following kinds:

Outage and leakage.
Price, etc. adjustments (debit or credit).
Rejected shipments.

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[1] A Los Angeles company recently found itself about to disburse several thousand dollars as gasoline tax on natural gasoline, through an oversight in including this class of commodity with other gasoline sales. Natural gasoline is sold for blending purposes, and is not, therefore, a finished product subject to State gasoline tax. The following list of gasoline taxes in effect Jan. 1, 1924, levied by the several states, may prove of interest:

States	Tax, Cents per Gallon
Arkansas	4
Arizona, Florida, Georgia, North Carolina, Oregon, South Carolina, and Virginia	3
Utah	2½
Alabama, California, Colorado, Delaware, Idaho, Indiana, Maryland, Montana, Nevada, Pennsylvania, South Dakota, Tennessee, Washington, and West Virginia	2
Connecticut, Kentucky, Louisiana, Maine, Mississippi, New Hampshire, New Mexico, North Dakota, Oklahoma, Texas, Vermont, and Wyoming	1

No difficulty should be encountered in connection with recording the first two classes. Where the quantity alleged to have been short is considerable, an affidavit is generally required from the party who gaged and tested the contents of the car before its unloading. Before the credit is approved, this information can be compared with the tests made by the company's own chemists at the time of shipment, and with the gage report from the loading rack.

When a tank car of product is rejected by the consignee, the usual practice is to reconsign and divert the car to some local jobber, rather than to incur the freight charges its return to the refinery would entail.

Upon receipt of rejection notice, a credit memo should be issued. The amount of the original invoice will be credited to the customer through the debit and credit memo register, and charged to the *Rejected Shipments* account, for which a column has been provided. Upon reconsignment, a debit memo will be issued against the new consignee; the amount of the original charge will be credited to rejected shipments, the adjusted charge made to accounts receivable, and any difference posted into one of the sales allowances columns. Care must be exercised that original invoice numbers are always shown, since the frequent practice of transferring the contents of a tank car into another car is likely to cause confusion. The open items in the rejected shipments column will represent the company's products rejected and not yet reconsigned. This account is controlled by the general ledger, and should be balanced monthly. For inventory purposes at the end of the month, the balance shown by the Rejected Shipments account should be reduced to approximate cost and the entry reversed at the beginning of the following month.

Other Earnings.—The company will have a certain amount of miscellaneous operating income, in addition to such items as interest, etc.

Tank-car Mileage.—Since tank-car operations are considered as coming within the activities of the marketing department, no account is here provided for income from tank-car mileage (see Part IV).

Rental Earnings.—Many of the large refineries own residence properties which are rented to employees. In addition to rents from this source, there are usually other kinds of rental income as for example, pipe-line, storage-tank and tool rentals. In the case of residence property, especially where there is a considerable investment in such property, a rental record should be maintained. The rents should be charged on the basis of a report from the refinery superintendent, and collections invariably made through the regular cash channels of the office. At regular intervals, the rent roll should be checked by a representative of the accounting department, and reported vacancies verified.

Steam, Electricity, etc. Sales.—Not infrequently the income arising from rendering service or selling some such item as water, steam or electricity to an outsider, is considerable in amount. Where this is the case, it is suggested that a record be designed to meet the requirements. If this is not done, some company may receive service for many months without charge. Water, for example, is often delivered through underground lines without metering and without any reports reaching the accounting department. Many refineries have not even a complete record of the location or number of their various product, steam, and water lines,[1] although this state of affairs is inexcusable.

Commissary Income.—In the event that the operation of the company commissary and restaurant results in a profit, the net amount thereof may be shown as a special item under miscellaneous income.

The operation of a company restaurant is usually placed in the charge of some outsider, as a concession; the company then provides sufficient of the staples to permit the concessionaire to realize a reasonable profit on a very moderate meal charge. This arrangement has the advantage of giving the workmen good meals at a low cost, both to themselves and to the company, and relieves the latter of the worry of operating the restaurant.

Where the system of selling commissary coupon books is in use, these should be numbered serially, and checked up with as great care as is accorded cash collections. As coupon book sales are made, an *Unredeemed Commissary Coupons* account should be credited. A register of coupon books should be kept, in which will be recorded month by month the coupons redeemed on each book, the open items being agreed with the general ledger control. The handling of coupon books is discussed in more detail in Chap. XXII.

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[1] In one case in Oklahoma, a new superintendent found it necessary to dig for buried pipe, in order to secure a record of the location of the various lines.

CHAPTER XIX

GENERAL ACCOUNTING RECORDS AND CLASSIFICATION OF ACCOUNTS

The executive accountant of a large petroleum refinery should be a man of broad experience and sound accounting knowledge, as regards both the technical aspects of accounting and the specialized accounts of oil producers, transporters, and refiners. Not only should he be capable of acting in the capacity of financial adviser to the management, for which work his intimate knowledge of the company's requirements and potentialities should make him peculiarly fitted, but he must also be able to systematize and supervise the organization's cost and operating records. Only too often the average refinery's accounts are in the charge of an individual whose experience and training have not fitted him for the position, and who regards a properly designed cost system as something entirely impossible of attainment.

Refinery operators as a rule are practical men, who are seldom interested in what they consider to be the wearisome details of accounting. They desire statements of the results of operations in an understandable and concise form, and to these they are of course entitled; if they fail to receive such statements, it cannot be expected that they will clearly understand the reasons, although they may vaguely infer that either the system, or the man responsible therefor (or both), is not exactly what it should be.

The records of a refinery are broadly divisible as to what may be termed:

Operating records, and
Financial records.

At certain points these two classes of records are so closely related as to make demarcation difficult, and rightly so, but generally speaking any report or record may be considered as either one or the other.

Operating Records.—By operating records are meant those reports from the various refinery units and centers of activity, which supply information concerning the technical operations of the plant, but which, except indirectly, have no place in the financial records of the company.

Still Report.—In order that the executives responsible for operating policy and results may be kept informed, it is customary for each plant unit to render a daily report. No special forms are suggested in any of these cases, but a still report should show, among other things:

Date.
Consecutive number.
Plant name.
Still number.
Type of distillation.
Time started charging.
Time fired.
Time finished charging.
Time over.
Time fire out.
Fuel used and quantity.
Commodity charged, with gravity and temperature.
From which tank charged.
Tank gages before and after charge.
Quantity charged (gallons).

Stillmen, by whom the stream is kept under observation, record temperature and gravity readings at short intervals, sometimes as often as every quarter of an hour; the interval depends on the unit, and the product undergoing treatment. These observations are, in many plants, chalked on a blackboard, and hourly observations recorded on the still report. The information will include:

Time of observation.
Stream temperature.
Vapor temperature.
Still temperature.
Stream gravity.
Tank number into which manifolding.
Time cut started.

Tank gages.
Quantity into tank (gallons).
Name of cut.
Percentage of cut to total still charge.

The report should also provide space for superintendent's instructions to stillmen, general remarks, and signatures of stillmen in charge during the run.

Agitator Report.—The report from the agitators should show the following information:

Date.
Consecutive number.
Plant name.
Agitator number.
Product charged.
Time started charging.
Duration of treatment.
Time finished discharging.
Gages, temperature, gravity and gallons before treatment.
Gages, temperature, gravity and gallons after treatment.
Loss.
Quantities used of sulphuric acid, fuming acid, caustic soda, flowers of sulphur, doctor solution, etc.
Remarks.
Signature of treater.

Daily Tank Gage (*Form* 21, page 212).—The daily tank gages form a part of the general accounting records, and have been discussed in detail in Chaps. XVI and XVII. The reports of intake and output, as shown by the various operating daily reports, should be checked with the daily tank gages, and any discrepancies investigated.

It will be noted on Form 21 that the daily gages are to be corrected to the normal temperature of 60°F. Most large companies have printed tables for this purpose, or make somewhat arbitrary computations; for the benefit of the smaller refiners the following table is appended.

The figures represent the fraction by which the gaged gallons must be multiplied in order to increase or reduce to the corrected gallonage at 60°F. The basis of calculation is the observed Baumé gravity of the gaged oil, and as long as this is known reasonably correctly, the calculation will be sufficiently accurate for all practical purposes. Many refiners carry out their results to several more figures, but it is doubtful whether greater accuracy results, as there will always be minor errors in the gages themselves, even if great care is exercised by the gager.

The table has been prepared from figures contained in *Circular* 57 of the Bureau of Standards of the Department of Commerce. The bureau's table shows the observed specific gravity, and the nearest degree Baumé has therefore been substituted herein. This method of adjustment of volume is made possible by the fact that all American oils of like gravity expand and contract in practically the same ratio or, to quote the *Circular:*

> This investigation has shown that within the limits of ordinary measurements the rate of change of specific gravity with change of temperature is the same for all oils of the same specific gravity. In the calculation of the expansion tables the average rate of expansion found for all oils of each designated specific gravity has been used.

The table has been prepared to include all products with gravities from 31 to 96°Bé. and within the temperatures of 30 and 120°F. A similar table covering oil with gravity down to 18°Bé. has already been included in this volume on page 68. In the case of run-down tanks containing products of higher temperatures, the following method will be found sufficiently accurate:

For All Products with Baumé Gravities		Deduct 1% from the Gaged Volume for Each
Between 18°	and 30°	25° above 60°F.
30°	40°	22° above 60°F.
40°	49°	20° above 60°F.
49°	58°	18° above 60°F.
58°	68°	16° above 60°F.
68°	82°	14° above 60°F.
82°	96°	12° above 60°F.

TABLE SHOWING FRACTION BY WHICH GAGED GALLONS

Degrees Fahrenheit	Observed degrees Baumé												
	31	33	35	37	39	41	43	45	47	49	52	54	57
30	1.013	1.013	1.014	1.014	1.014	1.015	1.015	1.016	1.016	1.017	1.017	1.018	1.018
32	1.012	1.012	1.013	1.013	1.013	1.014	1.014	1.014	1.015	1.015	1.016	1.017	1.017
34	1.011	1.011	1.012	1.012	1.012	1.013	1.013	1.013	1.014	1.014	1.015	1.015	1.016
36	1.010	1.010	1.011	1.011	1.011	1.011	1.012	1.012	1.013	1.013	1.014	1.014	1.014
38	1.009	1.009	1.010	1.010	1.010	1.010	1.011	1.011	1.012	1.012	1.012	1.013	1.013
40	1.009	1.009	1.009	1.009	1.010	1.010	1.010	1.010	1.011	1.011	1.011	1.012	1.012
42	1.008	1.008	1.008	1.008	1.009	1.009	1.009	1.009	1.010	1.010	1.010	1.011	1.011
44	1.007	1.007	1.007	1.007	1.008	1.008	1.008	1.008	1.009	1.009	1.009	1.010	1.010
46	1.006	1.006	1.006	1.007	1.007	1.007	1.007	1.007	1.007	1.008	1.008	1.008	1.009
48	1.005	1.005	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.006	1.007	1.007	1.007
50	1.004	1.004	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.005	1.006	1.006	1.006
52	1.003	1.003	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.005	1.005	1.005
54	1.002	1.002	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.004
56	1.001	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002	1.002
58	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001	1.001
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999	.999
64	.999	.999	.998	.998	.998	.998	.998	.998	.998	.998	.998	.998	.998
66	.998	.998	.997	.997	.997	.997	.997	.997	.997	.997	.997	.997	.997
68	.997	.997	.996	.996	.996	.996	.996	.996	.996	.996	.996	.996	.995
70	.996	.996	.996	.995	.995	.995	.995	.995	.995	.995	.995	.994	.994
72	.995	.995	.995	.995	.994	.994	.994	.994	.994	.994	.993	.993	.993
74	.994	.994	.994	.994	.994	.993	.993	.993	.993	.993	.992	.992	.992
76	.993	.993	.993	.993	.993	.993	.992	.992	.992	.992	.991	.991	.991
78	.992	.992	.992	.992	.992	.991	.991	.991	.991	.991	.990	.990	.990
80	.991	.991	.991	.991	.991	.990	.990	.990	.990	.989	.989	.989	.988
82	.991	.990	.990	.990	.990	.989	.989	.989	.989	.988	.988	.988	.987
84	.990	.989	.989	.989	.989	.989	.988	.988	.988	.987	.987	.987	.986
86	.989	.989	.988	.988	.988	.988	.987	.987	.987	.986	.986	.985	.985
88	.988	.988	.987	.987	.987	.987	.987	.986	.986	.985	.985	.984	.984
90	.987	.987	.987	.987	.986	.986	.986	.985	.985	.984	.984	.983	.983
92	.986	.986	.986	.986	.985	.985	.985	.984	.984	.983	.983	.982	.981
94	.985	.985	.985	.985	.985	.984	.984	.983	.983	.982	.982	.981	.980
96	985	.984	.984	.984	.984	.983	.983	.982	.982	.981	.981	.980	.979
98	.984	.984	.983	.983	.983	.982	.982	.981	.981	.980	.980	.979	.978
100	.983	.983	.982	.982	.982	.981	.981	.980	.980	.979	.979	.978	.977
102	.982	.982	.982	.981	.981	.980	.980	.979	.979	.978	.978	.977	.976
104	.981	.981	.981	.981	.980	.980	.979	.979	.978	.977	.977	.976	.975
106	.981	.980	.980	.980	.979	.979	.978	.978	.977	.976	.976	.975	.974
108	.980	.980	.979	.979	.978	.978	.977	.977	976	.975	.975	.974	.973
110	.979	.979	.978	.978	.977	.977	.976	.976	.975	.974	.974	.973	.972
112	.978	.978	.978	.977	.977	.976	.976	.975	.974	.973	.973	.972	.971
114	.977	.977	.977	.976	.976	.975	.975	.974	.973	.972	.972	.971	.970
116	.977	.976	.976	.975	.975	.974	.974	.973	.972	.971	.971	.970	.969
118	.976	.975	.975	.974	.974	.973	.973	.972	.971	.970	.970	.969	.968
120	.975	.975	.974	.974	.973	.973	.972	.971	.970	.969	.969	.968	.967

Miscellaneous Reports.—The following units and departments should also be required to render reports of their daily activities, but the information to be shown will depend upon the purpose for which the reports are intended. In some cases, a basis for distributing expenses to the various other plant units will be secured by this means, while in other cases the data will be entirely statistical.

MUST BE MULTIPLIED IN ORDER TO CORRECT TO 60°F.

Degrees Fahrenheit	Observed degrees Baumé												
	59	62	64	67	70	73	76	79	82	85	89	92	96
30	1.019	1.020	1.020	1.021	1.021	1.022	1.023	1.023	1.024	1.025	1.026	1.027	1.028
32	1.018	1.018	1.019	1.019	1.020	1.020	1.021	1.022	1.022	1.023	1.024	1.025	1.026
34	1.016	1.017	1.017	1.018	1.018	1.019	1.019	1.020	1.021	1.022	1.022	1.023	1.024
36	1.015	1.015	1.016	1.016	1.017	1.017	1.018	1.019	1.019	1.020	1.021	1.021	1.022
38	1.014	1.014	1.015	1.015	1.016	1.016	1.016	1.017	1.017	1.018	1.019	1.020	1.020
40	1.013	1.013	1.014	1.014	1.014	1.015	1.015	1.016	1.016	1.017	1.017	1.018	1.019
42	1.011	1.012	1.012	1.012	1.013	1.013	1.014	1.014	1.015	1.015	1.016	1.016	1.017
44	1.010	1.011	1.011	1.011	1.011	1.012	1.012	1.012	1.013	1.014	1.014	1.015	1.015
46	1.009	1.009	1.009	1.010	1.010	1.010	1.010	1.011	1.011	1.012	1.012	1.013	1.013
48	1.007	1.008	1.008	1.008	1.008	1.009	1.009	1.009	1.010	1.010	1.010	1.011	1.011
50	1.006	1.006	1.007	1.007	1.007	1.007	1.008	1.008	1.008	1.008	1.009	1.009	1.009
52	1.005	1.005	1.005	1.005	1.006	1.006	1.006	1.006	1.006	1.007	1.007	1.007	1.007
54	1.004	1.004	1.004	1.004	1.004	1.004	1.004	1.005	1.005	1.005	1.005	1.005	1.006
56	1.002	1.002	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003	1.003
58	1.001	1.001	1.001	1.001	1.001	1.001	1.002	1.002	1.002	1.002	1.002	1.002	1.002
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	.999	.999	.999	.999	.999	.999	.999	.998	.998	.998	.998	.998	.998
64	.998	.997	.997	.997	.997	.997	.997	.997	.997	.997	.997	.997	.997
66	.996	.996	.996	.996	.996	.996	.996	.995	.995	.995	995	.995	.995
68	.995	.995	.995	.995	.994	.994	.994	.994	.994	.994	.993	.993	.993
70	.994	.994	.994	.993	.993	.993	.993	.993	.992	.992	.992	.991	.991
72	.993	.993	.992	.992	.992	.992	.991	.991	.991	.990	.990	.989	.989
74	.992	.991	.991	.991	.991	.990	.990	.990	.989	.989	.988	.988	.987
76	.990	.990	.990	.989	.989	.989	.989	.988	.988	.987	.987	.986	.986
78	.989	.989	.989	.988	.988	.988	.987	.987	.987	.986	.985	.985	.984
80	.988	.987	.987	.987	.986	.986	.985	.985	.985	.984	.984	.983	.982
82	.987	.986	.986	.985	.985	.985	.984	.984	.983	.983	.982	.981	.981
84	.986	.985	.985	.984	.984	.983	.983	.982	.982	.981	.980	.980	.979
86	.984	.984	.983	.983	.982	.982	.981	.981	.980	.980	.979	.978	.978
88	.983	.983	.982	.981	.981	.980	.980	.979	.979	.978	.977	.977	.976
90	.982	.981	.981	.980	.980	.979	.978	.978	.977	.977	.976	.975	.974
92	.981	.980	.980	.979	.978	.978	.977	.976	.976	.975	.974	.974	.973
94	.980	.979	.979	.978	.977	.976	.976	.975	.974	.974	.973	.972	.971
96	.979	.978	.977	.976	.976	.975	.974	.974	.973	.972	.971	.970	.969
98	.977	.977	.976	.975	.974	.974	.973	.972	.972	.971	.970	.969	.968
100	.976	.975	.975	.974	.973	.972	.972	.971	.970	.969	.968	.967	.966
102	.975	.974	.974	.973	.972	.971	.970	.970	.969	.968	.967	.966	.965
104	.974	.973	.972	.972	.971	.970	.969	.968	.967	.966	.965	.964	.963
106	.973	.972	.971	.971	.969	.968	.968	.967	.966	.965	.964	.963	.962
108	.972	.971	.970	.969	.968	.967	.966	.965	.964	.963	.962	.961	.960
110	.971	.970	.969	.968	.967	.966	.965	.964	.963	.962	.961	.960	.959
112	.970	.969	.968	.967	.966	.965	.964	.963	.962	.961	.960	.958	.957
114	.969	.968	.967	.966	.965	.964	.963	.962	.961	.959	.958	.957	.956
116	.968	.967	.966	.965	.964	.962	.961	.960	.959	.958	.957	.956	.954
118	.967	.966	.965	.964	.962	.961	.960	.959	.958	.957	.955	.954	.953
120	.966	.965	.964	.962	.961	.960	.959	.958	.957	.955	.954	.953	.951

Reports should be made, along the same general lines as indicated for the still and agitator reports, in the cases of:

Hydraulic filter-press unit,
Sweater and wax finishing unit,
Lubricants filter unit,
Kerosene finishing unit,
Compounding house, etc.

A *Rentals and services report* should be compiled by the refinery superintendent periodically, showing particulars of amounts which the company is entitled to collect for houses rented, steam, water and electricity sold, pumping service rendered, etc.

Each of the operating service departments below should report each day concerning the details of its operations, as well as the plant units served:

Steam plant,
Pumping plant,
Water plant,
Electric plant,
Sulphuric acid reclamation plant,
Fuller's earth burning plant.

Financial Records.—The general accounting records of a refinery may conveniently comprise the following:

General ledger
Journal voucher
Process expense analysis, Form 22 (page 213)
Process cost ledger, Forms 23*a* and 23*b* (pages 214 and 215)
Sales journal, Form 24 (page 216)
Debit and credit memo register, Form 25 (page 217)
Voucher record, Form 26 (page 218)
Cash voucher, Form 27 (page 219)
Cash receipts, Form 28 (page 220)
Cash disbursements, Form 29 (page 221).

General Ledger.—The loose-leaf form of general ledger will be found to be much more satisfactory than a bound book. It is suggested that the journal form of ledger page be used, and that accounts be arranged in balance sheet and income statement order. Alphabetical arrangement of accounts is not so satisfactory.

Journal Voucher.—A journal voucher form is not presented since it need be of no special design. It is intended that the journal voucher supplant the old-fashioned general journal. There are two good systems of preparing journal vouchers; in one, the voucher is made out in duplicate, one copy being filed in a post binder, while the other is placed in a voucher file with supporting papers attached. The other system requires only one copy of the journal voucher; any supporting papers are placed in a regular folder, such as is used for correspondence filing, and these are arranged in journal voucher number order. The latter method possesses the advantage of allowing unlimited space for supporting papers, and permits the voucher to be written in longhand, rather than on a typewriter.

The most convenient system for numbering is that of prefixing the letter "J," to denote journal voucher, followed by another letter or number to designate the month. Some companies have found that a system which indicates both month (by a letter) and year (by figures) is very satisfactory. For example, "JB 245" might be used to describe journal voucher number 5 of February, 1924.

Process Expense Analysis (*Form* 22).—This form is intended to furnish an analysis of the Process Costs account in the general ledger, and should be kept by processes, one sheet being used for each process unit.

It will be observed that the subdivision of expenses under each process is such that only items of particular interest are set out separately. Many companies subdivide differently the expenses of each process, and as a result are unable to keep their expense forms within reasonable limits. Many postings will be made direct from the cash vouchers, but the following expenses will be obtained from the sources indicated:

Product used will be obtained at the end of the month, after costs have been computed (see Chap. XVII), and should be brought into the accounts by journal voucher.

Labor cost will be secured from an analysis of the monthly payroll, and should be posted from the distributing journal voucher which closes the payroll clearing account.

Fuel used will, in most cases, be represented by fuel oil taken from the company's stocks. The information regarding quantities consumed will be secured from the reports of the various operating units, these reports being verified with the daily tank gages. Fuel is most conveniently costed at the stock price at the beginning of the month, even where some of the current month's production has been used.

Stores used will include chemicals, waste, oil, packing, etc., and should be charged to the account *Chemicals, supplies and expense.* The totals will be obtained from the periodic journal voucher which distributes stores issues.

The *Depreciation* charge will come from a journal voucher recording the monthly depreciation computations. It will be a simple matter to make these monthly calculations if, as provided in the classification of accounts, the capital assets are grouped in the same order as is used for expenses.

Taxes and insurance will result from the closing of the similarly captioned clearing account; see the discussion of clearing accounts in Chap. XVI.

Service departments and general expense will be obtained from the monthly clearance of service accounts, the charges coming from one or more of the clearing journal vouchers.

After all postings have been made for the month, and the process expense analysis sheets have been agreed with the general ledger control, the totals shown by the respective analysis columns should be transferred to the process cost ledger, in the spaces provided therefor.

Process Cost Ledger (*Forms* 23*a* and 23*b*).—This record has been discussed in Chap. XVII, and requires no further comment. It is to be kept by processes, one sheet for each of the units.

Sales Journal and Debit and Credit Memo Register (*Forms* 24 and 25).—These records are designed to record all of the company's transactions in respect of the sale of its products. Each record has received discussion in Chap. XVIII.

Voucher Record (*Form* 26).—The voucher record has been designed so that the columns follow the arrangement of the accounts in the appended card of accounts.

Casinghead Gasoline Plants.—The manufacture of casinghead gasoline from natural gas, while constituting a separate branch of the petroleum industry, differs in no particular respect from a single process unit in a complete refinery, as far as accounting is concerned.

Raw Material.—The raw material used is the casinghead gas, which is generally obtained from oil-producing companies at their wells. The gas is purchased under contract, and a very common provision is that which requires the return of the dry, or *stripped*, gas to the producing company, without charge. In this event the raw material cost is the original outlay for gas; where, however, the purchasing company retains the dry gas, selling it or using it for fuel, the raw material cost is represented by the original cost, less the sales value of the dry gas.

Classification of Accounts.—It has been thought unnecessary to prepare a separate card of accounts for casinghead plants. The expenses should be conveniently subdivided, first according to operations, as for example, compressors, absorbers, stills, etc., and then by the main elements of expense, as:

Absorption medium and ammonia,
Labor,
Fuel, steam and water,
Repairs,

Depreciation,
Other supplies and expense.

Such items as the absorption medium, and ammonia in the refrigeration system, may be considered to be working assets; these can be charged into operating costs either by prorating as exhausted, or by carrying the product in the system at a fixed figure and charging the cost of all renewals to expense.

Where a gasoline plant is operated as an adjunct of a complete refinery, the better plan is to treat it as a distinct entity, and to bring the blend gasoline into the general refinery's stocks at production cost.

Classification of Accounts.—In arranging the appended card of accounts, endeavor has been made to provide a comprehensive list of accounts and to make each caption self-descriptive. The classifications of several of the large companies were carefully perused in this connection:

CARD OF ACCOUNTS FOR

CAPITAL ASSETS

Land
Process equipment:
  Crude still unit, Process I
  Agitator and steam still unit, Process II
  Tar still unit, Process III
  Hydraulic filter-press unit, Process IV
  Sweater and wax-finishing unit, Process V
  Reducing still unit, Process VI
  Lubricants filter unit, Process VII
  Kerosene finishing unit, Process VIII
Service equipment:
  Steam plant
  Pumping plant
  Water wells and equipment
  Electric plant
  Sulphuric acid reclamation plant
  Fuller's earth burning plant
  Crude and unfinished product tanks
General equipment:
  Warehouse
  Office
  Laboratory
  Finished product tanks
  Pipe and fittings
  Machine shop and tools
  Railroad sidings
  Delivery facilities
Automobiles and trucks
Furniture and fixtures
Uncompleted construction
Reserve for depreciation (credit)

INVESTMENTS

Investments in and advances to affiliated companies
Employees' residence property
Other securities owned
Sinking fund deposits

CURRENT ASSETS

Material stores
Crude oil stock
Product stocks—unfinished
Product stocks—finished
Rejected shipments
Notes receivable
Accounts receivable
Reserve for doubtful accounts (credit)
Due from officers and employees
U. S. Government securities
Cash in banks
Petty cash funds

DEFERRED CHARGES

Insurance premiums unexpired
Interest prepaid
Unamortized expense on capital and bond issues
Prepaid expense, miscellaneous

CAPITAL AND LIABILITIES

Capital stock, preferred
Capital stock, common
Funded debt
Purchase money obligations
Notes payable, bankers
Notes payable, others
Vouchers payable
Dividends payable
Salaries and wages accrued
Interest accrued
Taxes accrued
Employers' liability insurance
Other accrued expenses
Provision for Federal income tax
Reserve for agitator relining
Reserve for contingencies
Capital surplus
Earned surplus
Dividends paid
Profit and loss

A REFINING COMPANY

INCOME

Sales to affiliated companies
Sales to outsiders
Sales allowances (debit)
Cost of sales
  (The above four accounts may well be subdivided as to products)
Rental earnings
Discounts received
Investment income — affiliated companies
Investment income—other
Interest on Government securities
Miscellaneous income

SERVICE AND CLEARING ACCOUNTS

Process costs
Payroll
Steam plant expense
Pumping expense
Water wells expense
Electric plant expense
Sulphuric acid reclamation expense
Fuller's earth burning expense
Storage expense, crude and unfinished products
Depreciation
Taxes and insurance
Miscellaneous refinery payroll and expense

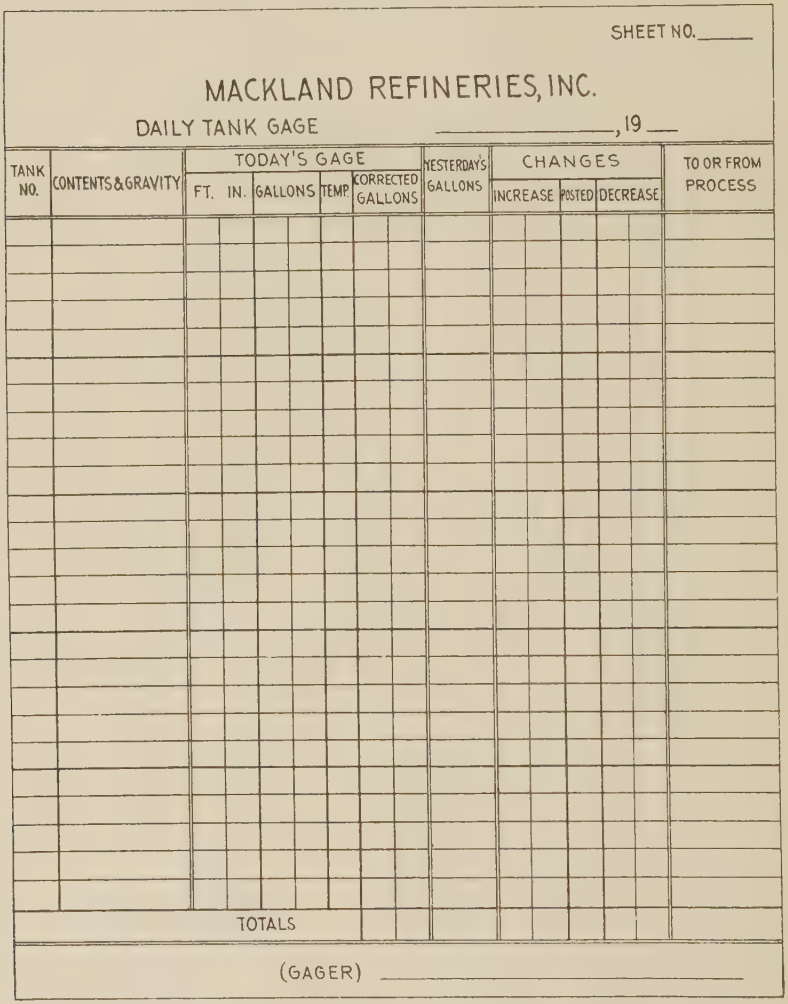
EXPENSES

General refinery:
  Warehouse expense
  Laboratory expense
  Commissary and restaurant
  General repairs
  Injuries and damages
  Depreciation

Selling:
  Finished product storage
  Delivery facilities
  Advertising
  Traveling and automobile
  Salaries, commission and expenses

Administration:
  Executive salaries
  Office salaries
  Office supplies and expenses
  Traveling and automobile
  General taxes
  Legal and auditing

General:
  Charitable contributions
  Interest
  Income tax
  Provision for contingencies



SHEET NO.______

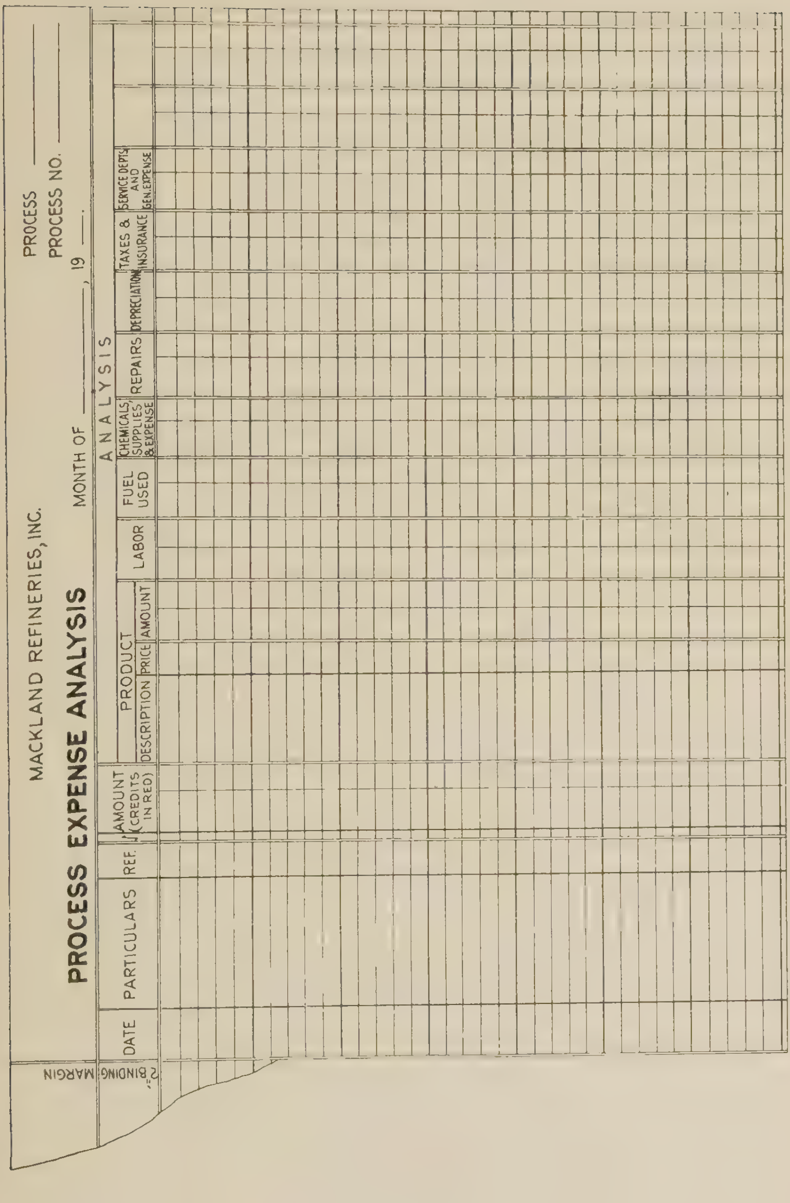
MACKLAND REFINERIES, INC.

DAILY TANK GAGE ________________, 19___

TANK NO.	CONTENTS & GRAVITY	TODAY'S GAGE					YESTERDAY'S GALLONS	CHANGES			TO OR FROM PROCESS
		FT.	IN.	GALLONS	TEMP.	CORRECTED GALLONS		INCREASE	POSTED	DECREASE	
TOTALS											

(GAGER) ________________________________

FORM 21.—Refinery department—daily tank gage. (8½ × 11 in.)



MACKLAND REFINERIES, INC.

PROCESS EXPENSE ANALYSIS

PROCESS ______

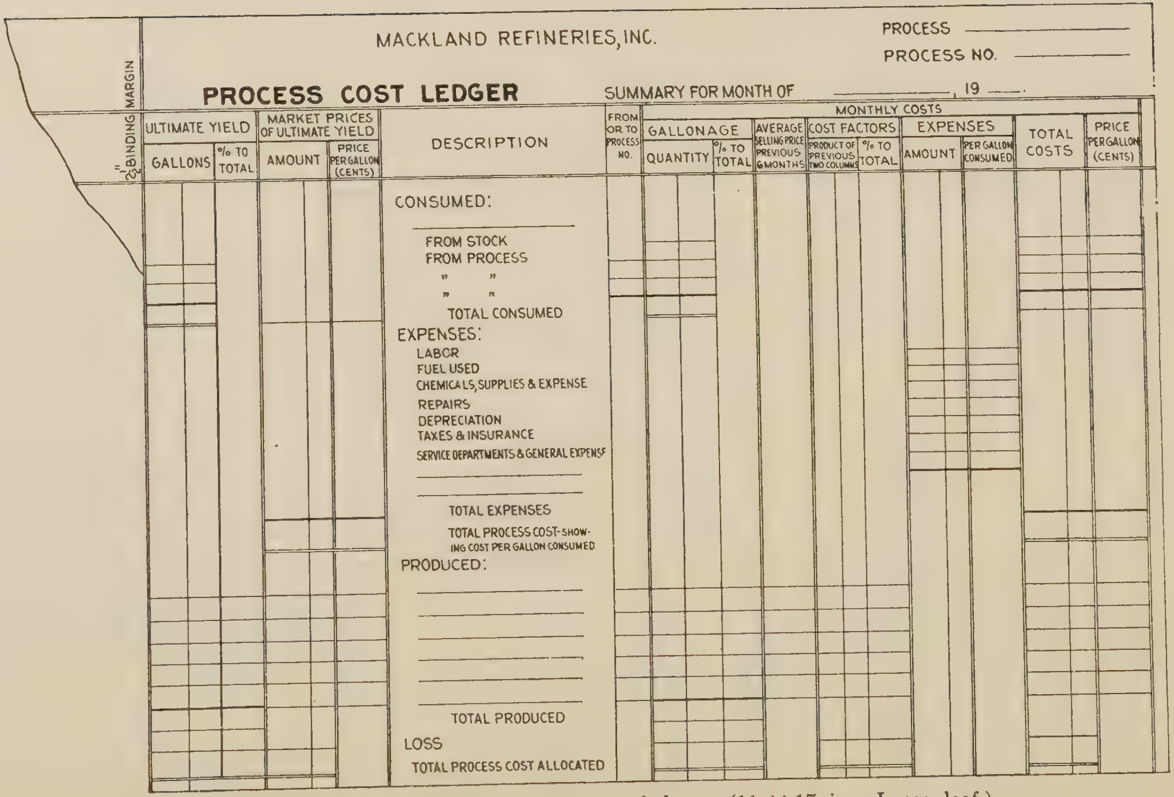
PROCESS NO. ______

MONTH OF ______, 19__.

2" BINDING MARGIN

DATE	PARTICULARS	REF.	AMOUNT (CREDITS IN RED)	PRODUCT			ANALYSIS								
				DESCRIPTION	PRICE	AMOUNT	LABOR	FUEL USED	CHEMICALS, SUPPLIES & EXPENSE	REPAIRS	DEPRECIATION	TAXES & INSURANCE	SERVICE DEPTS. AND GEN. EXPENSE		

FORM 22.—Refinery department—process expense analysis. (17 × 11 in. Loose leaf.)



2½" BINDING MARGIN

MACKLAND REFINERIES, INC.

PROCESS ________

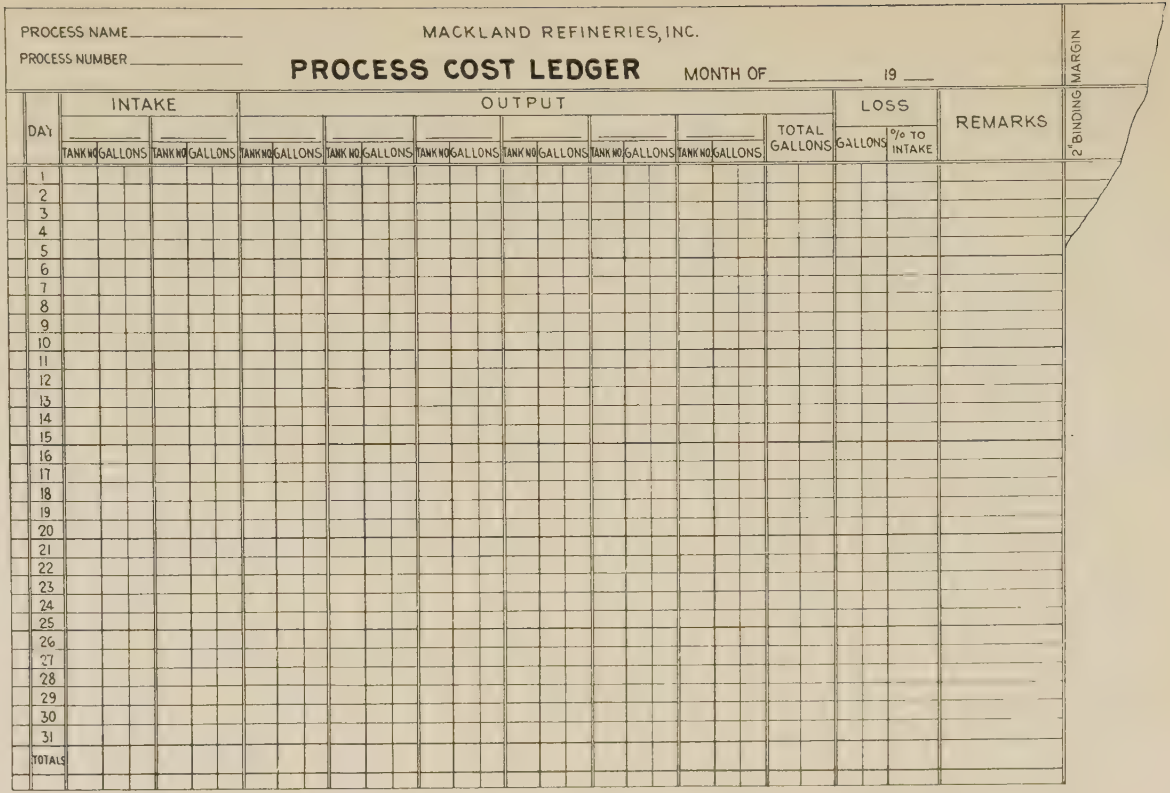
PROCESS NO. ________

PROCESS COST LEDGER

SUMMARY FOR MONTH OF ________, 19__.

ULTIMATE YIELD		MARKET PRICES OF ULTIMATE YIELD		DESCRIPTION	FROM OR TO PROCESS NO.	MONTHLY COSTS								
						GALLONAGE		AVERAGE SELLING PRICE PREVIOUS 6 MONTHS	COST FACTORS		EXPENSES		TOTAL COSTS	PRICE PER GALLON (CENTS)
GALLONS	% TO TOTAL	AMOUNT	PRICE PER GALLON (CENTS)			QUANTITY	% TO TOTAL		PRODUCT OF PREVIOUS TWO COLUMNS	% TO TOTAL	AMOUNT	PER GALLON CONSUMED		
				CONSUMED:										
				FROM STOCK										
				FROM PROCESS										
				" "										
				" "										
				TOTAL CONSUMED										
				EXPENSES:										
				LABOR										
				FUEL USED										
				CHEMICALS, SUPPLIES & EXPENSE										
				REPAIRS										
				DEPRECIATION										
				TAXES & INSURANCE										
				SERVICE DEPARTMENTS & GENERAL EXPENSE										
				TOTAL EXPENSES										
				TOTAL PROCESS COST-SHOWING COST PER GALLON CONSUMED										
				PRODUCED:										
				TOTAL PRODUCED										
				LOSS										
				TOTAL PROCESS COST ALLOCATED										

FORM 23*a*.—Refinery department—process csot ledger. (11 × 17 in. Loose leaf.)



PROCESS NAME ____________

PROCESS NUMBER ____________

MACKLAND REFINERIES, INC.

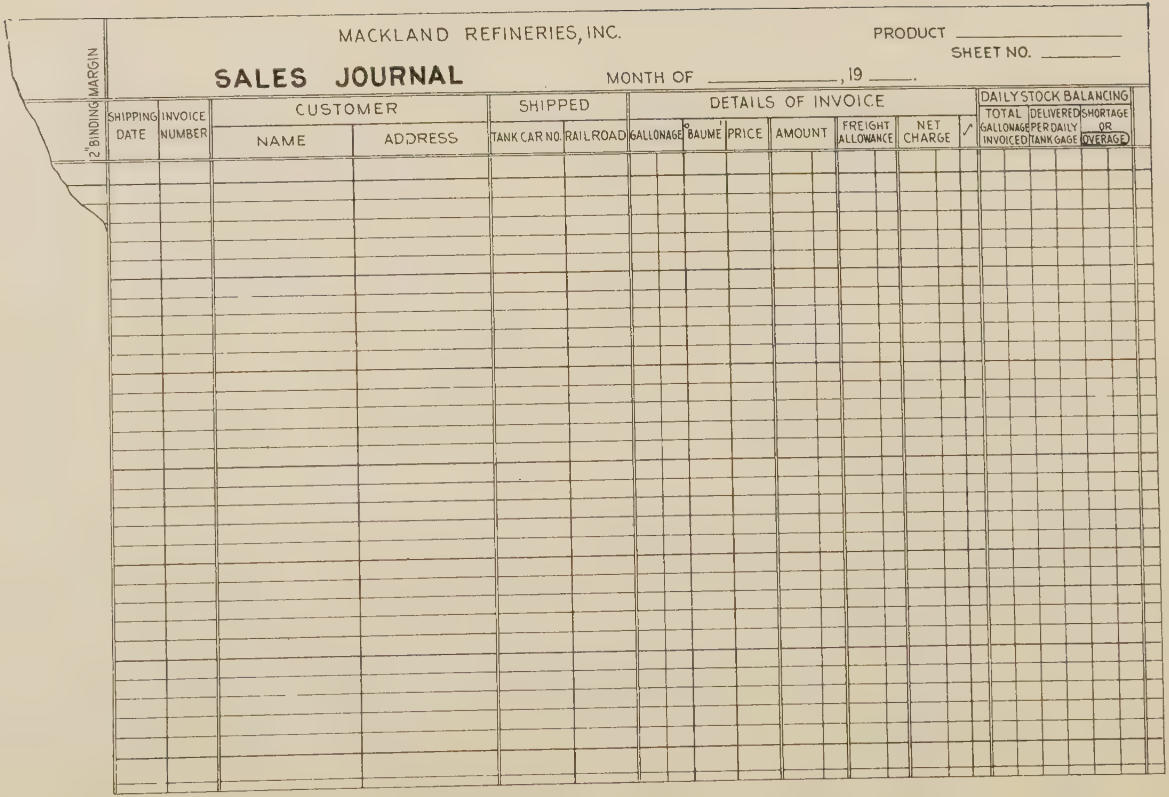
PROCESS COST LEDGER

MONTH OF ____________ 19 ___

2" BINDING MARGIN

DAY	INTAKE				OUTPUT												TOTAL GALLONS	LOSS		REMARKS
	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS	TANK NO	GALLONS		GALLONS	% TO INTAKE	
1																				
2																				
3																				
4																				
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				
27																				
28																				
29																				
30																				
31																				
TOTALS																				

FORM 23*b*.—Refinery department—process cost ledger (reverse side). (11 × 17 in. Loose leaf.)



MACKLAND REFINERIES, INC.

PRODUCT ____________

SHEET NO. ______

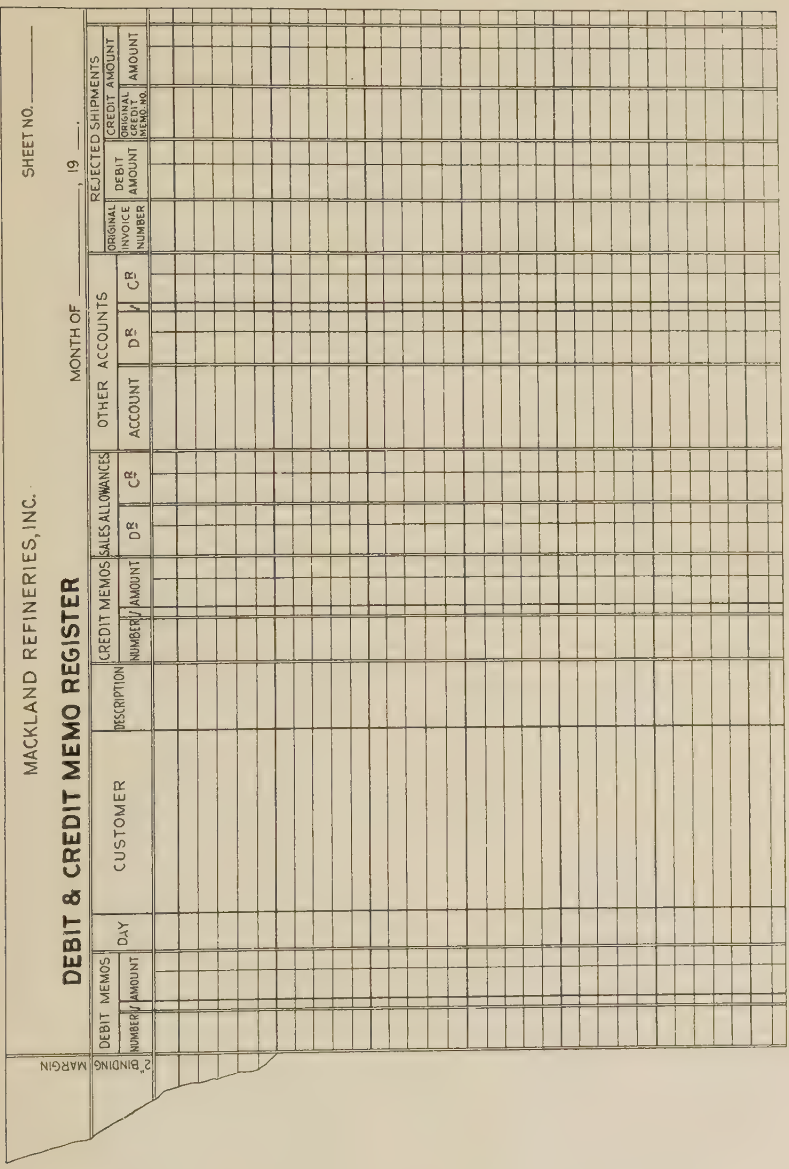
SALES JOURNAL

MONTH OF __________, 19____.

2" BINDING MARGIN

SHIPPING DATE	INVOICE NUMBER	CUSTOMER		SHIPPED		DETAILS OF INVOICE							DAILY STOCK BALANCING		
		NAME	ADDRESS	TANK CAR NO.	RAILROAD	GALLONAGE	° BAUME	PRICE	AMOUNT	FREIGHT ALLOWANCE	NET CHARGE	✓	TOTAL GALLONAGE INVOICED	DELIVERED PER DAILY TANK GAGE	SHORTAGE OR (OVERAGE)

Form 24.—Refinery department—sales journal. (17 × 11 in. Loose leaf.)



MACKLAND REFINERIES, INC.

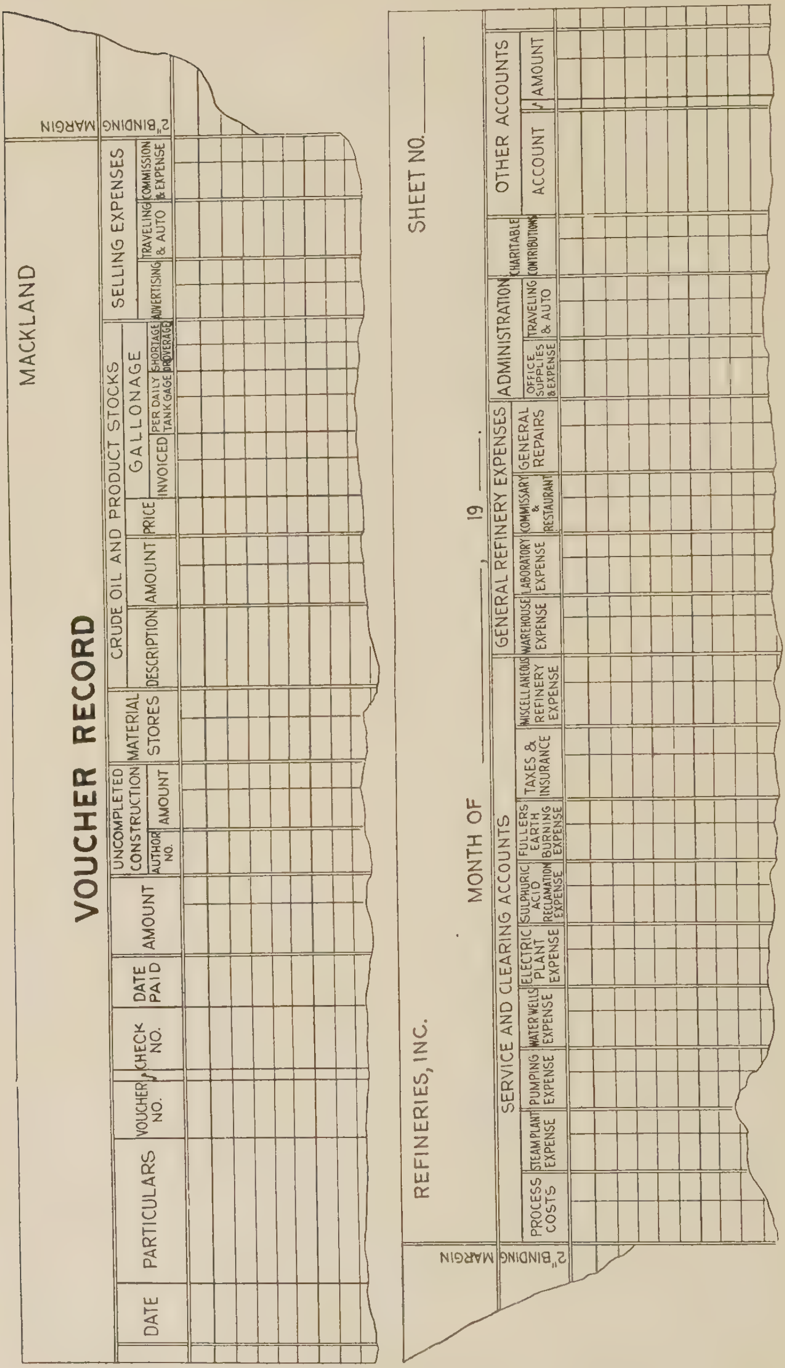
SHEET NO. _____

DEBIT & CREDIT MEMO REGISTER

MONTH OF ________, 19__.

2" BINDING MARGIN	DEBIT MEMOS			DAY	CUSTOMER	DESCRIPTION	CREDIT MEMOS			SALES ALLOWANCES		OTHER ACCOUNTS				REJECTED SHIPMENTS			
	NUMBER	✓	AMOUNT				NUMBER	✓	AMOUNT	DR.	CR.	ACCOUNT	DR.	✓	CR.	ORIGINAL INVOICE NUMBER	DEBIT AMOUNT	CREDIT AMOUNT ORIGINAL CREDIT MEMO NO.	CREDIT AMOUNT AMOUNT

FORM 25.—Refinery department—debit and credit memo register. (17 × 11 in. Loose leaf.)



VOUCHER RECORD

MACKLAND REFINERIES, INC.

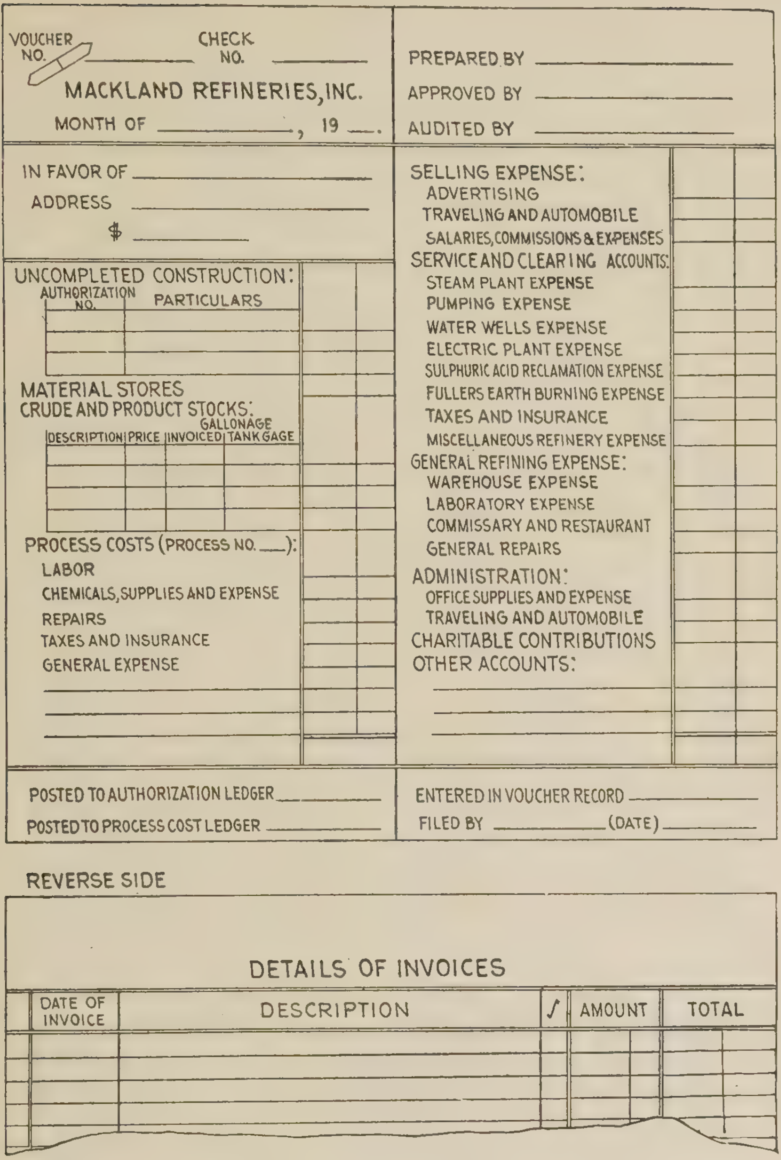
MONTH OF ________, 19__.

SHEET NO.____

DATE	PARTICULARS	VOUCHER NO.	✓	CHECK NO.	DATE PAID	AMOUNT	UNCOMPLETED CONSTRUCTION		MATERIAL STORES	CRUDE OIL AND PRODUCT STOCKS						SELLING EXPENSES			2" BINDING MARGIN
							AUTHOR NO.	AMOUNT		DESCRIPTION	AMOUNT	PRICE	GALLONAGE			ADVERTISING	TRAVELING & AUTO	COMMISSION & EXPENSE	
													INVOICED	PER DAILY TANK GAGE	SHORTAGE OVERAGE				

2" BINDING MARGIN	SERVICE AND CLEARING ACCOUNTS									GENERAL REFINERY EXPENSES				ADMINISTRATION		CHARITABLE	OTHER ACCOUNTS		
	PROCESS COSTS	STEAM PLANT EXPENSE	PUMPING EXPENSE	WATER WELLS EXPENSE	ELECTRIC PLANT EXPENSE	SULPHURIC ACID RECLAMATION EXPENSE	FULLERS EARTH BURNING EXPENSE	TAXES & INSURANCE	MISCELLANEOUS REFINERY EXPENSE	WAREHOUSE EXPENSE	LABORATORY EXPENSE	COMMISSARY & RESTAURANT	GENERAL REPAIRS	OFFICE SUPPLIES & EXPENSE	TRAVELING & AUTO	CONTRIBUTIONS	ACCOUNT	✓	AMOUNT

FORM 26.—Refinery department—voucher record. (17 × 11 in. Loose leaf.)



VOUCHER NO. ________ CHECK NO. ________

MACKLAND REFINERIES, INC.

MONTH OF ____________, 19___.

PREPARED BY ____________

APPROVED BY ____________

AUDITED BY ____________

IN FAVOR OF ____________

ADDRESS ____________

$ ____________

UNCOMPLETED CONSTRUCTION:

AUTHORIZATION NO.	PARTICULARS

MATERIAL STORES

CRUDE AND PRODUCT STOCKS:

DESCRIPTION	PRICE	GALLONAGE INVOICED	GALLONAGE TANK GAGE

PROCESS COSTS (PROCESS NO. ___):

LABOR

CHEMICALS, SUPPLIES AND EXPENSE

REPAIRS

TAXES AND INSURANCE

GENERAL EXPENSE

____

____

____

SELLING EXPENSE:

ADVERTISING

TRAVELING AND AUTOMOBILE

SALARIES, COMMISSIONS & EXPENSES

SERVICE AND CLEARING ACCOUNTS:

STEAM PLANT EXPENSE

PUMPING EXPENSE

WATER WELLS EXPENSE

ELECTRIC PLANT EXPENSE

SULPHURIC ACID RECLAMATION EXPENSE

FULLERS EARTH BURNING EXPENSE

TAXES AND INSURANCE

MISCELLANEOUS REFINERY EXPENSE

GENERAL REFINING EXPENSE:

WAREHOUSE EXPENSE

LABORATORY EXPENSE

COMMISSARY AND RESTAURANT

GENERAL REPAIRS

ADMINISTRATION:

OFFICE SUPPLIES AND EXPENSE

TRAVELING AND AUTOMOBILE

CHARITABLE CONTRIBUTIONS

OTHER ACCOUNTS:

____

____

____

POSTED TO AUTHORIZATION LEDGER ____________

POSTED TO PROCESS COST LEDGER ____________

ENTERED IN VOUCHER RECORD ____________

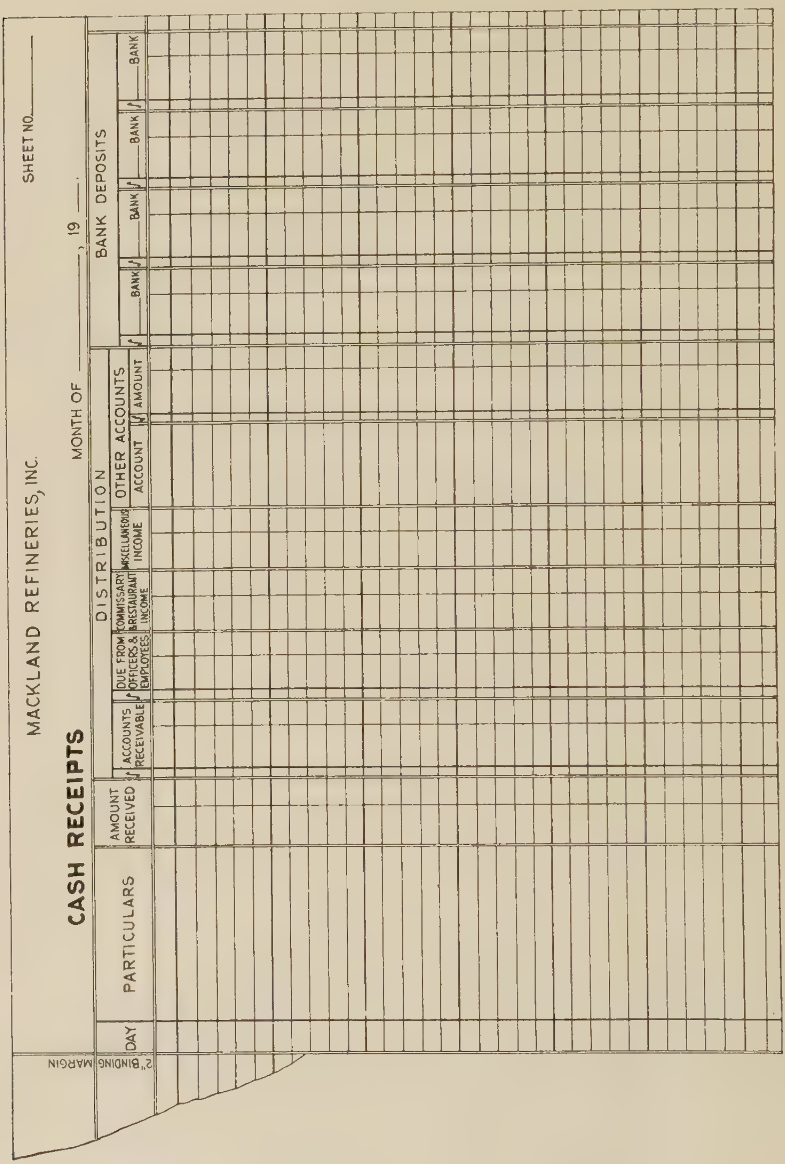
FILED BY ____________ (DATE) ____________

REVERSE SIDE

DETAILS OF INVOICES

	DATE OF INVOICE	DESCRIPTION	✓	AMOUNT	TOTAL

FORM 27.—Refinery department—cash voucher. (8½ × 9¼ in.)



2" BINDING MARGIN

CASH RECEIPTS

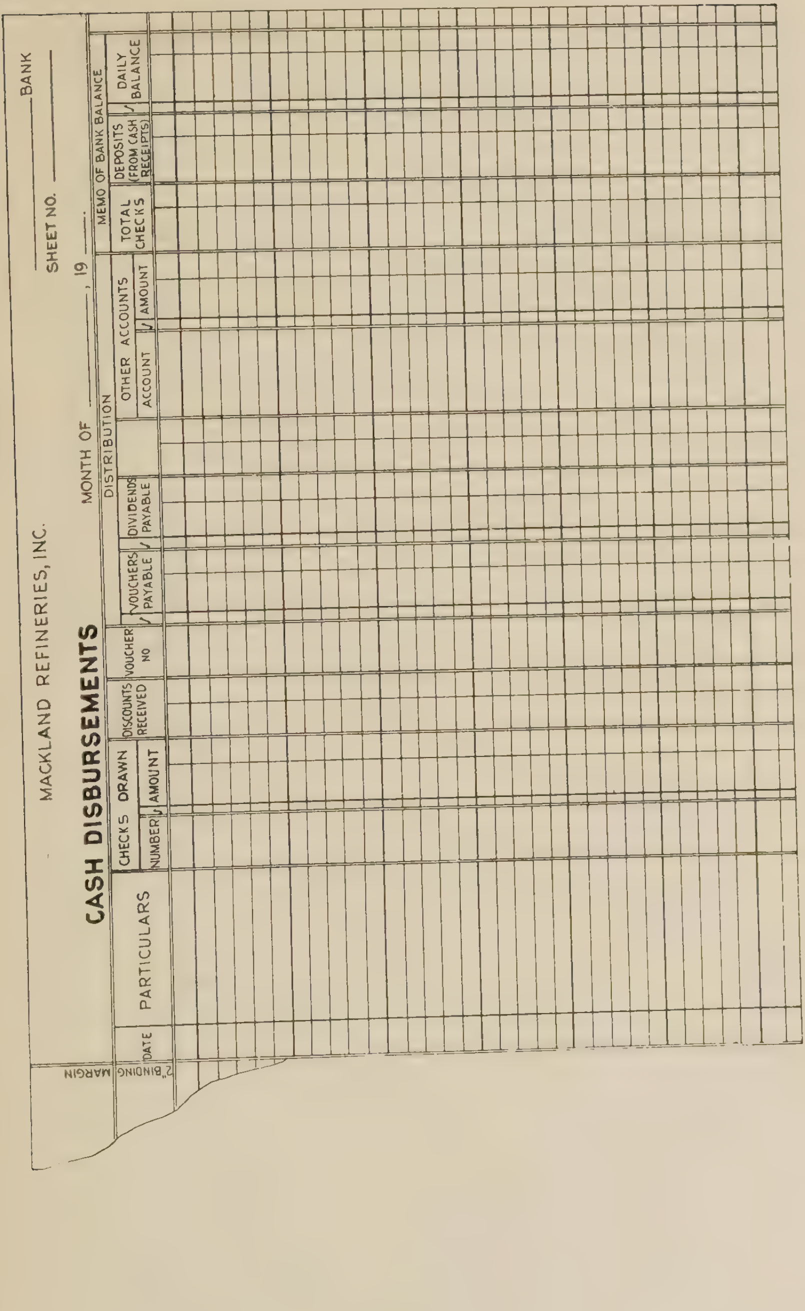
MACKLAND REFINERIES, INC.

MONTH OF ________, 19___.

SHEET NO.____

DAY	PARTICULARS	AMOUNT RECEIVED	DISTRIBUTION										BANK DEPOSITS							
			✓	ACCOUNTS RECEIVABLE	✓	DUE FROM OFFICERS & EMPLOYEES	COMMISSARY & RESTAURANT INCOME	MISCELLANEOUS INCOME	OTHER ACCOUNTS			✓	____BANK	✓	____BANK	✓	____BANK	✓	____BANK	
									ACCOUNT	✓	AMOUNT									

FORM 28.—Refinery department—cash receipts. (17 × 11 in. Loose leaf.)



MACKLAND REFINERIES, INC.

CASH DISBURSEMENTS

MONTH OF ________, 19__ SHEET NO. ________ ________ BANK

2" BINDING MARGIN

DATE	PARTICULARS	CHECKS DRAWN			DISCOUNTS RECEIVED	VOUCHER NO	DISTRIBUTION						MEMO OF BANK BALANCE			
		NUMBER	✓	AMOUNT			VOUCHERS PAYABLE ✓	DIVIDENDS PAYABLE		OTHER ACCOUNTS ACCOUNT	✓	AMOUNT	TOTAL CHECKS	DEPOSITS (FROM CASH RECEIPTS)	✓	DAILY BALANCE

FORM 29.—Refinery department—cash disbursements. (17 × 11 in. Loose leaf.)

PART IV

MARKETING

CHAPTER XX

MARKETING PRACTICE

Marketing the products of crude petroleum, from the point of view either of the marketing organization or of the refiner, may be divided as to:

- Retail sales
  - through service filling stations.
- Wholesale sales
  - by motor truck, tank car and tank steamer.

Retail Sales through Service Stations.—Most of the large American oil companies have a complete marketing organization, each geographical division of which is in the charge of a resident sales manager. It is not unusual to find several hundred service stations in one division, and it can readily be seen that the task of accounting for purchases, sales, transfers, etc. of each of these divisions is no mean one.

A common practice among the smaller companies is to construct filling stations at various points, and to lease them to independent operators, under an agreement which provides that only company products be handled. The company then makes regular deliveries to these stations by motor truck.

In order to meet competition in the larger cities, a retail marketing organization is obliged to expend considerable capital for the purchase of conveniently located service station sites, and in the erection of stations thereon. The fact has been proved in many cities that corners at which one or more filling stations are already situated furnish the best possible location for another station, the new station having the surprising effect of increasing the sales of the other stations.

Tanks for storing gasoline at the stations are buried underground, while lubricating oil storing is generally done in steel drums. The service station is in the charge of an attendant, who is responsible to a superintendent of service stations; he reports his daily requirements to the nearest distributing station, makes cash and credit sales from his station, and usually banks his cash collections in a nearby bank each day.

Attendants.—It is a difficult matter to secure a complete and adequate check on filling station accounts, and since the company must trust in a certain measure to the employees' integrity for its protection, considerable care should be exercised in selecting men for the positions of attendants.

In this connection, it may be observed that in those sections of the country where competition is keen, extra and gratuitous services are rendered at the stations in order to attract custom, and that the appearance and personality of attendants count for much. An example is furnished in comparative practice: In the middle-western states it is not unusual for an attendant to put air in the tires of a car driven by a woman, but beyond a few courtesies of this kind, little goodwill promotion is done. However, in cities along the Pacific coast, attendants fairly pounce upon incoming machines and, during the time required to fill the gasoline tanks, they generally manage to polish the windshield, fill the radiator, test and replenish the air in the tires, and discuss presidential probabilities or the Eighteenth Amendment.

It might be mentioned that a few of the smaller companies in different sections of the country have fallen into the deplorable practice of measuring an attendant's ability by the product overages he is able to show. This means that the employee is forced to resort to giving short measurement to customers; so that, not only is the company sure to lose trade as the policy continues, but the practice is likely to develop in the employee an elasticity of conscience which will eventually justify his defrauding the company quite as easily as the public.

With respect to the losses arising from shortages, it should be remembered that gasoline is measured into the filling station storage tank on the basis of 60°F., but that no such adjustment is made in the volume sold to customers. As a consequence, stations situated in parts of the country with a warm climate, as well as all stations during the hot summer months, will have a considerable gain in volume, since gasoline expands with heat; in other words the customer receives less gasoline when it is hot than when it is cold. In the winter, of course, the stations are likely to show product shortages. It is rumored that some stations have even gone to the length of installing heating coils in their gasoline tanks in order to take advantage of the resulting volumetric increase.

Distribution of Service Stations in the United States.—As far as the authors are aware there are no reliable statistics concerning the number of filling stations in America; however, the table on page 228 showing by states the registration of automobiles as at July 1, 1924, will serve to convey some idea of the probable number, for, allowing (say) one station for each 100 automobiles, there would be some 155,000 stations. The table has also been drawn up to show the estimated population of, and persons per car in, each state.

Price Changes.—As is well known, the retail price for gasoline is subject to change without notice, and often apparently for no good reason. The following table of high and low retail prices during 1923 in a number of representative cities, together with the number of price changes, is interesting:

State	City	Retail gasoline price, cents per gallon		Number of changes
		High	Low	
Alabama	Birmingham	20	14	8
California	San Francisco	19	12	5
Colorado	Denver	20	12	11
Georgia	Atlanta	22	13	10
Illinois	Chicago	20	12	5
Indiana	Indianapolis	20.8	12.2	6
Iowa	Des Moines	21.1	12.5	5
Kentucky	Louisville	21	13	9
Louisiana	New Orleans	19.5	10.5	14
Maryland	Baltimore	22.5	15	10
Minnesota	Minneapolis	21.5	12.9	5
Missouri	Kansas City	18.5	10.8	13
Nebraska	Omaha	20.5	12.2	5
New Jersey	Newark	23.5	15.5	9
New Mexico	Albuquerque	25.5	17	15
New York	New York City	24.5	15.5	11
Ohio	Cleveland	21	16	7
Oregon	Portland	20	13	5
Pennsylvania	Philadelphia	23	14	11
Rhode Island	Providence	24.5	15.5	13
Tennessee	Memphis	20	12	14
Utah	Salt Lake City	23	15.5	11
Wisconsin	Milwaukee	20.6	12	5
Washington	Seattle	20	13	4

State	Registration of cars and trucks		Estimated population as at July 1, 1923[1]		Persons per car
New England:					
Maine	105,061		777,259		7.4
New Hampshire	64,370		447,592		6.9
Vermont	52,614		352,428		6.7
Massachusetts	561,836		4,027,545		7.2
Rhode Island	78,413		626,672		8.0
Connecticut	185,763	1,048,057	1,476,483	7,707,979	7.9
Middle Atlantic:					
New York	1,169,145		10,843,661		9.3
New Jersey	435,894		3,378,963		7.7
Pennsylvania	1,088,387	2,693,426	9,100,326	23,322,950	8.4
East North Central:					
Ohio	1,160,000		6,117,122		5.3
Indiana	581,575		3,013,134		5.2
Illinois	986,480		6,790,524		6.9
Michigan	765,044		3,977,821		5.2
Wisconsin	474,063	3,967,162	2,739.579	22,638,180	5.8
West North Central:					
Minnesota	462,777		2,499,396		5.4
Iowa	569,358		2,468,643		4.3
Missouri	477,056		3,443,971		7.2
North Dakota	102,824		672,041		6.5
South Dakota	127,400		655,532		5.1
Nebraska	276,592		1,333,922		4.8
Kansas	361,031	2,377,038	1,797,489	12,870,994	5.0
South Atlantic:					
Delaware	35,000		230,460		6.6
Maryland	175,718		1,505,295		8.6
District of Columbia	75,401		437,571		5.8
Virginia	229,784		2,398,441		10.4
West Virginia	151,222		1,551,156		10.3
North Carolina	285,000		2,686,325		9.4
South Carolina	139,245		1,744,408		12.5
Georgia	175,100		2,999,196		17.1
Florida	170,000	1.436,470	1,046,287	14,599,139	6.1
East South Central:					
Kentucky	214,000		2,462,317		11.5
Tennessee	165,170		2,393,077		14.5
Alabama	133,309		2,423,912		18.2
Mississippi	114,070	626,549	1,790,618	9,069,924	15.7
West South Central:					
Arkansas	116,865		1,816,287		15.5
Louisiana	143,000		1,849,746		12.9
Oklahoma	295,000		2,162,079		7.3
Texas	661,949	1,216,814	4,939,630	10,767,742	7.5
Mountain:					
Montana	69,100		611,199		8.8
Idaho	63,268		470,179		7.4
Wyoming	37,800		211,864		5.6
Colorado	187,675		990,320		5.3
New Mexico	38,275		372,265		9.7
Arizona	49,161		380,960		7.7
Utah	67,133		476,812		7.1
Nevada	15,995	528,407	77,407	3,591,006	4.8
Pacific:					
Washington	290,438		1,433,998		4.9
Oregon	161,739		823,270		5.1
California	1,180,800	1,632,977	3,805,153	6,062,421	3.2
Total continental United States	....	15,526,900	....	110,630,335	7.1

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[1] From estimates prepared under the supervision of Charles S. Sloane, Geographer of the Census (Estimates of Population of the United States, Government Printing Office, Washington, D. C.).

Wholesale Sales.—Wholesale marketing, by motor truck, tank car, tank ship, and by freight car in the case of products in containers, has come to require the attention of specialists.

Product Storage.—The company's stocks of products are generally kept at distributing stations, conveniently located to railroad sidings and to the service stations. Many of the smaller refiners, who market their own products direct, do most of the storing at the refinery tank farm.

Storage facilities are of two kinds; gasoline and other light products are transported in tank cars, and stored in steel tanks, while lubricating oils and greases, though stored in bulk in steel tanks and barrels, are generally placed in 50-gallon steel drums, tin cans, or other containers before being marketed. Kerosene for export is shipped in small 5- and 10-gallon containers. In California and Wyoming, where considerable road oil is produced,[1] the oil is shipped from the refinery hot, in specially insulated tank cars and frequently is spread on the roads by the seller's trucks.

Where considerable quantities of products are kept at a main supply point, the storage of these products is under the supervision of a superintendent of storage. From this main supply point, the various distributing stations are supplied by tank-car shipments.

In some localities the practice of exchanging oil and products is quite general among oil companies. Where one company has a quantity of a given product situated at some point, and desires to transport it elsewhere, it endeavors to exchange the product for a similar quantity at the desired point, instead of moving it by means of pipe line or tank car. The practice effects a considerable saving for both parties to the transaction, since neither is compelled to incur the transportation charges.

The motor truck deliveries from the distributing stations are under the direction of a dispatcher who supplies the truck drivers with instructions, oversees the loading and unloading of the trucks, and checks them in at the end of the day.

Tank-car, etc. Distribution.—The major portion of the wholesale sales are made in tank-car lots, in the case of light oils, and in freight-car lots, in the case of lubricants, etc.

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[1] The manufacture of road oil is essentially a skimming, or topping, process and is usually carried out in retorts similar to crude stills. Skimming plants may be regarded as employing the first process of a complete refinery.

The company's tank cars and tank ships[1] are under the supervision of a traffic department, and are systematically controlled at all times. Based upon sales orders, loading instructions are issued daily to the loading racks foremen, who forward the filled orders to the laboratory together with samples of the oil shipped. In the laboratory various tests are made and the results noted on the shipping ticket received from the loading racks. The procedure in the case of steamer and barge shipments is essentially the same as in the case of tank cars, the loading being done from the company's wharves.

Although railroads over whose lines the tank cars travel always make necessary repairs, invoicing the company therefor, most companies also maintain a repair shop wherein they may overhaul the cars at regular intervals. Where cars are not given careful attention they deteriorate very rapidly, especially if they are not painted periodically. Under the modern painting methods of spraying by means of compressed air, the labor involved is not great.

The larger companies often maintain a can and cooperage shop in addition to their other operations, manufacturing theirown brands of barrels, cans, cases, etc., and packing the bulk products therein.

Weights and Measures Equivalents.—Those companies which export large quantities of products to foreign markets are often obliged to convert American volumes and weights into equivalent foreign measurements; in this connection the following tables will be of service:

VOLUME EQUIVALENTS

Unit	Equivalent to—						
	Cubic feet	Cubic inches	Cubic meters	Gallons, U. S.	Gallons, Imperial	Barrels, U. S.	Liters
Cubic foot....	....	1,728	.0283	7.481	6.232	.1781	28.317
Cubic inch....	.000579	....	.0000164	.00433	.00361	.000103	.0164
Cubic meter..	35.314	61,023	....	264.17	220.097	6.288	1,000
Gallon, U. S..	.1337	231	.00378	....	.833	.0238	3.785
Gallon, Imperial ...	.1605	277.274	.00454	1.200	....	.0286	4.545
Barrel, U. S...	5.615	9,702	.159	42	34.99	....	159
Liter.........	.035	61.023	.001	.264	.220	.00629	

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[1] Tank cars are usually of 6,000-, 8,000-, or 10,000-gallon capacity, approximately, with a length over all of about 35 feet. Coast-wise tankers are of about 7,000 tons capacity, while transatlantic tankers range from 10,000 to 15,000 tons.

Weight Equivalents

Unit	Equivalent to—		
	Pounds	Kilograms	Poods
Pound	....	.45359	.02769
Kilogram	2.2046	....	.06105
Pood (Russian)	36.112	16.38	

Volume and Weight Equivalents at Various Gravities

Degrees Baumé	Pounds per gallon	Gallons per pound	Degrees Baumé	Pounds per gallon	Gallons per pound	Degrees Baumé	Pounds per gallon	Gallons per pound
10	8.328	.1201						
11	8.269	.1209	41	6.817	.1467	71	5.798	.1725
12	8.211	.1218	42	6.777	.1476	72	5.769	.1733
13	8.153	.1227	43	6.738	.1484	73	5.741	.1742
14	8.096	.1235	44	6.699	.1493	74	5.712	.1751
15	8.041	.1244	45	6.661	.1501	75	5.685	.1759
16	7.986	.1252	46	6.623	.1510	76	5.657	.1768
17	7.931	.1261	47	6.586	.1518	77	5.629	.1776
18	7.877	.1270	48	6.548	.1527	78	5.602	.1785
19	7.825	.1278	49	6.511	.1536	79	5.576	.1793
20	7.772	.1287	50	6.476	.1544	80	5.549	.1802
21	7.721	.1295	51	6.440	.1553	81	5.522	.1811
22	7.670	.1304	52	6.404	.1562	82	5.497	.1819
23	7.620	.1313	53	6.369	.1570	83	5.471	.1828
24	7.570	.1321	54	6.334	.1579	84	5.445	.1837
25	7.522	.1330	55	6.300	.1587	85	5.420	.1845
26	7.473	.1338	56	6.266	.1596	86	5.395	.1854
27	7.425	.1347	57	6.233	.1604	87	5.370	.1862
28	7.378	.1355	58	6.199	.1613	88	5.345	.1871
29	7.332	.1364	59	6.166	.1622	89	5.320	.1880
30	7.286	.1373	60	6.134	.1630	90	5.296	.1888
31	7.241	.1381	61	6.102	.1639	91	5.272	.1897
32	7.196	.1390	62	6.070	.1647	92	5.248	.1905
33	7.152	.1398	63	6.038	.1656	93	5.225	.1914
34	7.108	.1407	64	6.007	.1665	94	5.201	.1923
35	7.065	.1415	65	5.976	.1673	95	5.178	.1931
36	7.022	.1424	66	5.946	.1682	96	5.155	.1940
37	6.980	.1433	67	5.916	.1690	97	5.132	.1949
38	6.939	.1441	68	5.886	.1699	98	5.110	.1957
39	6.898	.1450	69	5.856	.1708	99	5.088	.1966
40	6.857	.1459	70	5.827	.1716	100	5.066	.1974

CHAPTER XXI

TANK-CAR PURCHASE CONTRACTS

Mention has been made that the petroleum industry's investment in tank cars has been estimated to approximate $270,000,000. The enormity of this figure indicates that much of the capital of the larger companies is invested in this class of equipment. It should be remembered, moreover, that a relatively small quantity of crude oil is moved by tank car, and that therefore by far the larger number of the cars must be owned by refining and marketing organizations.

Since investors in oil securities have grown somewhat more cautious of late years, new companies endeavoring to market their securities are often met with requests for such large discounts that they are obliged to seek other means of financing. One common method of acquiring equipment is that in which the vendor retains title to the subject matter of the contract until the entire purchase price has been paid; the contract usually provides for periodic payments on account, in the guise of rentals, with title passing to the purchasing company only at the termination of the rental period.

Obligations of this nature should appear in the accounts of the purchasing company as *purchase money obligations*, the liability being reduced on the books as payments on principal are made. The determination of what portion of each payment applies against principal requires a careful calculation, and it is with the scientific methods for making this computation that the present chapter is concerned.

It is proposed in the following pages to deal with those tank-car purchase contracts whereunder a certain fixed *rental* is paid, over a period of years, but with the proviso that if at the end of the specified period payments have been regularly met, the title to the cars will be transferred on payment of a further nominal consideration. Under such contracts it is usual for the tank-car manufacturer to maintain the cars in a proper state of repair, and they are generally plainly placarded as the property of the tank-car company, leased to the purchaser.

It frequently happens that the contract provides for periodic installments, but does not state the respective principal and interest amounts included therein. Many accountants, under these circumstances, treat the entire amounts of the installments as capital, overlooking the fact that the interest included should be charged to expense. Some accountants, on the other hand, argue that these *hire-purchase contracts* constitute merely a rental arrangement during the term of the contract, and they therefore charge the total installments to expense. They base their contention on a clause in the agreement which provides that in case installments are not met on time, the contract is canceled and all previous installments paid, forfeited. In that event (a very remote contingency, as the equity in a contract could in most cases be disposed of, even if the contracting company were unable to keep up its payments), a loss would be sustained as at the date of forfeiture, and as such would be chargeable against profits.

The only correct method is, of course, to treat the transaction as a purchase from the start, setting up the asset amongst the properties and the net cash liability under purchase money obligations; the practical difficulty arises in apportioning the installments as between principal, interest, and repairs.

Let us take, as an example, a contract which provides for the purchase of one tank car, payments to be made over a period of 5 years, the vendor being obligated to keep the car in proper repair during the term of the contract. Installments of $175 are to be paid every 3 months, the total amount payable during the 5 years being therefore $3,500.

It will first be necessary to ascertain the cash value of the car at the time of purchase; the tank-car company will willingly furnish this information. This, we will suppose for our particular car, is $2,500. The difference of $1,000 will, of course, represent interest on unpaid installments, together with payments to the tank-car company for necessary repairs.

A reasonable interest rate should then be assumed; 6 per cent per annum is usual, and has been accepted by the Treasury Department in a number of such cases for tax purposes.

It is assumed that payments for repairs are to be made in equal quarterly installments, so that a definite amount out of each quarterly $175 will represent repairs, and will be chargeable, as such, to expense. The remaining portion of the $175 installment will represent a payment on the principal of the \$2,500 purchase price, together with interest on the diminishing balance.

The problem is analogous to an unknown annuity of twenty periodic payments the present value of which is \$2,500, and all interest upon which is to be computed at the rate of 1½ per cent per period. The following algebraic equation is applicable:

$$v = \frac{p(R^t - 1)}{R^t(R - 1)}$$

where v = the present value of the annuity
p = the periodic payment
R = the amount of 1 for one period, and
t = the number of periods.[1]

Our unknown quantity, in the present problem, is p, and we may therefore restate the formula as:

$$p = \frac{v \times R^t(R - 1)}{R^t - 1}$$

Substituting our known quantities we have:

$$\begin{aligned} p &= \frac{2{,}500 \times 1.015^{20} \times .015}{1.015^{20} - 1} \\ &= \frac{2{,}500 \times 1.346855 \times .015}{.346855} \quad \text{(see footnote 2)} \\ &= \frac{50.507062}{.346855} \\ &= \underline{\$145.61} \end{aligned}$$

We have ascertained that of each \$175 installment, \$145.61 represents principal and interest, and the balance (\$29.39) repairs. We can now construct a table showing the composition of each installment, as follows:

---

[1] Of course, if the accountant has a book of annuity tables by him, he will be able to calculate the periodic payment with its aid.

[2] Note that the twentieth power of 1.015 is more easily obtained with the aid of logarithmic tables, than by laborious multiplication.

Period	Principal at beginning of each period	Installment			
		Total	Repairs	Interest	Principal payment
First.........	$2,500.00	$ 175.00	$ 29.39	$ 37.50	$ 108.11
Second.......	2,391.89	175.00	29.39	35.88	109.73
Third........	2,282.16	175.00	29.39	34.23	111.38
Fourth.......	2,170.78	175.00	29.39	32.56	113.05
Fifth.........	2,057.73	175.00	29.39	30.87	114.74
Sixth.........	1,942.99	175.00	29.39	29.14	116.47
Seventh......	1,826.52	175.00	29.39	27.40	118.21
Eighth.......	1,708.31	175.00	29.39	25.62	119.99
Ninth........	1,588.32	175.00	29.39	23.82	121.79
Tenth........	1,466.53	175.00	29.39	22.00	123.61
Eleventh.....	1,342.92	175.00	29.39	20.14	125.47
Twelfth......	1,217.45	175.00	29.39	18.26	127.35
Thirteenth....	1,090.10	175.00	29.39	16.35	129.26
Fourteenth...	960.84	175.00	29.39	14.41	131.20
Fifteenth.....	829.64	175.00	29.39	12.45	133.16
Sixteenth.....	696.48	175.00	29.39	10.45	135.16
Seventeenth..	561.32	175.00	29.39	8.42	137.19
Eighteenth...	424.13	175.00	29.39	6.36	139.25
Nineteenth...	284.88	175.00	29.39	4.27	141.34
Twentieth....	143.54	175.00	29.39	2.15	143.46
		$3,500.00	$587.80	$412.28	$2,499.92

It will be seen that our calculations brought us within 8 cents of the exact result, and we may adjust the division of the twentieth installment to make up this difference, charging $2.07 to interest and increasing the principal proportion to $143.54.

CHAPTER XXII

STATION AND TRUCK REPORTING

A complete accounting system for stocks of merchandise should record both quantities and values, whether the subject matter be shoes, or ships, or sealing wax. Instances sometimes arise, however, which require that the strict letter of accounting theory be departed from, in order that the demands of practicability be met.

In the case of wholesale purchases and sales, or transfers, and in that of distributing station receipts and deliveries where quantities are considerable, there is no good reason why these should not be definitely accounted for, regardless of the size of the company or the number of products handled. In connection with service stations, however, a multiplicity of products, more than, say, twenty-five or thirty, makes it debatable whether the cost of precise accounting for quantities will not exceed the product losses at the end of the month, where no such exact accounting is undertaken.

For the sake of convenience, in the discussion which follows, the marketing division of the industry may be further divided as to:

Distributing stations,
Motor truck delivery,
Service (filling) stations, and
Distribution by tank car,

and the functions of each of these classes may comprise any or all of

Receipt by purchase or transfer,
Storing,
Delivery by sale or transfer.

Purchase of Products.—The marketing company will procure the products which it sells either from the refining division of an allied company, or by outside purchase. The products handled may include, among other commodities, several brands of

Gasoline,
Kerosene,
Gas oil,
Fuel oil,
Road oil,
Lubricating oils, and
Lubricating greases.

As purchases are made, the cost thereof will be charged through the voucher record into product stocks. The tank-car register, explained in detail later, will furnish a complete analysis of all commodities received by tank car or steamer, and will also indicate the disposition made of the purchase. Stations should not buy products, except in emergency; in case of a station purchase, the amount should be taken up in product stocks through the voucher record when receipt is reported on the station daily report. All product purchases shown by the voucher record must be accounted for, either on a station and truck daily report or in the tank-car register.

Station and Truck Daily Report (**Forms 30***a*, **30***b*, **and 30***c*, **pages 251, 252 and 253**).—The system suggested in the following paragraphs has been designed so that a complete accounting is made by stations each day, and so that in checking up any station it will only be necessary to go over transactions since the completion of the last report.

Many companies find it impracticable, owing to a variety of reasons, to keep daily check on all stocks at service stations. In these circumstances they usually require merely a report of all credit sales, and an accounting for all gasoline sold as shown by the pump meters; the balance of the cash received, as shown by the cash register, being aggregated as "other products sold." At the end of the month inventories of stocks are made and the accounts adjusted to agree therewith.

It appears that by this method too much confidence is put in the integrity of the station attendant, and various means have been tried out by different companies to make the station records more complete. Under one system, each attendant is supplied with small tickets, somewhat in the form of a street-car transfer, which he punches for quantities and commodities in the case of all sales other than gasoline. Another method is to place a card behind each class of product storage, on which the issues can be entered as they are made, very much as in the case of a bin record of a factory storeroom. Whatever method is adopted, it is essential that a cash register be provided so that a means of balancing his cash is available to the chief attendant. There is no objection, of course, to providing each attendant with a small change fund so that patrons need not be delayed, but the sale should always be rung up on the cash register afterwards.

In the system outlined herein, it will be necessary for quantities of all products to be accounted for by some method or another, both at the filling stations and by the distributing stations and trucks. Further, all transfers between stations will be supported by regular sales tickets, which may be of the same form as those used for sales to outsiders; the original will be turned in to the office by the station receiving the merchandise, and the duplicate, properly signed for by the receiving station, will support the delivering station's report.

By this means, the reports of one station will check those of another, and no dispute can subsequently arise as to any delivery. A copy of the daily report should be retained by the reporting station, where it will be available for reference or for check by the traveling auditor.

The station and truck daily report should be prepared by all distributing stations, service stations, and motor trucks. Distributing stations include all points at which products are held in storage for distribution to other units of the organization.

The uses of the form will be apparent with some few explanations. The receipt of various commodities during each day will be entered on this form by the reporting station or truck. Each entry, classified as purchase or receipt, and as to source, should show ticket or invoice number, and quantity received. In the case of purchases, the amount of the purchase should also be shown; entries for transfers from other stations or from trucks, however, should show only quantities. If more space is required for either purchases, transfers, or sales, than is provided by Form 30*a*, the additional entries should be made on Form 30*c*, care being taken that the sheet is properly designated as purchases, or sales, etc.

All charge sales made by a station or truck should be entered on a charge ticket, the duplicate being handed to the customer and the original, signed for by the customer, posted in the proper spaces on the station and truck daily report; these originals will be turned in to the office and will provide the basis for entry to customers' ledger accounts. A separate ticket should also be made for the total of cash sales for the day, and for bookkeeping convenience a cash sales account for each station will be carried as a customer in the general office.

Coupons redeemed should be treated by service stations as cash, and rung up on the cash register as such. At the end of the day the total *cash* shown by the cash register either will be turned into the office as coupons, or banked. The method of dealing with these coupons in the general office, is discussed in Chap. XXIII.

In order to balance the daily report, it is only necessary to bring forward the stocks shown by the previous report, add quantities purchased and received by transfer, and thus reach the total quantities to be accounted for. This accounting will be made by adding to the quantities sold, the deliveries to stations and trucks, and the day's gaged stocks. The total of these items should complete the accounting for quantities, and any difference should be entered in the "short or over" line.

The reverse side of the station and truck report (Form 30*b*), should give a complete summary of the day's cash and coupon collections, together with the disposition thereof. The matter of holding attendants and drivers responsible for cash and product shortages is in the company's discretion.

The gasoline-pump readings and tank gages, as shown, should agree with the information entered on the front of the report, the total sales disclosed by the pumps being accounted for in quantities sold and transferred; and since the quantity shown by the pump readings, less quantity transferred, will equal quantity sold, this latter at the selling price of the product for the day, should agree with the sales reported and accounted for.

This form of report furnishes an excellent safeguard against fraud, but in spite of this, all stations should receive frequent audit by a staff of competent internal auditors.[1]

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[1] The California division of one of the largest companies recently uncovered by accident a system of fraud extending over a considerable period of time. It appears that one of the truck drivers lowered his report of daily receipts approximately 500 gallons each day; a colluding confederate at the general office changed the distributing station's reports of deliveries to agree, and the two of them shared in the proceeds of the 500 gallons. The shortage losses shown by the particular station had always been high, but it had been nobody's business to perceive any significance in the fact, especially since the station handled several thousand gallons per day. Of course, the fraud would have been detected at once, had the internal auditors compared original station reports with the copy on file in the general office.

A system of reporting such as outlined, will have no value unless the reports are carefully checked and recorded in the general office; spaces for initialing the report have been provided at the foot thereof. The clerk or clerks assigned to the checking of the reports, should attend to the following matters:

1. All tickets and invoices turned in should be checked to the report, the tickets being scrutinized to see that they are properly signed.
2. Coupons turned in should be footed and agreed in total with the report. They should then be canceled, preferably with a perforating date machine.
3. Stocks should be checked forward from the previous report, including pump readings and tank gages.
4. Any shortages over a fixed amount should be listed and reported to the district sales manager.
5. Transfers between stations should be checked in detail.
6. All footings to be checked in detail, including transferring of subtotals.
7. All totals to be carried to the summary, Form 31(page 254).

The report can then go to the cashier's department for entry in the cash book, and the tickets and coupons turned over to the ledger keeper and clerk in charge of the coupon register, respectively.

Summary of Station and Truck Reports (Form 31, page 254). In order that a complete record may be had of the purchases, sales, and overs or shorts of all distributing stations, service stations, and trucks, individual summary sheets should be prepared of the daily reports from each station and truck, a separate sheet being used for each item.

At the end of the month, the summary sheets of each of the stations will require further summary, in order to secure total purchases, sales and overs or shorts; this summarizing may also be done on one of the summary sheets. The purchases shown by this summary, together with those shown by the tank-car register, should agree with the total purchases shown by the voucher record.

At first thought, it may appear that the system outlined will involve too great a volume of detail work, especially where stations or products are numerous. However, the alternative method which requires that the stations account only in groups of products is not recommended. It should be kept in mind that, while considerable detail work is necessary in the first case, complete control of the accounts cannot otherwise be obtained.

Tank-car Register (Form 32, page 255).—This register is designed to furnish a complete record of all receipts by tank car or tank ship, and to account for the disposition of the products. It will also afford a detail analysis of shipments in transit. As tank cars of product are received, entry should be made in the record, showing all information for which space has been provided. As the cars are consigned, either to outsiders or to the company's stations, entry should be made in the "transferred" and the "delivered" columns. Between-station transfer freight will be shown in the transfer freight column. Deliveries will be entered in the sold column, in both gallons and value, in the case of sales to outsiders. Where the delivery is made to a station, entry should be made, in gallons only, in the own stations column.

Any difference between quantity received and that delivered, should be posted in the shortage column and the total of the column journalized at the end of the month.

Shipments in transit will be represented by the open items in the register, and can conveniently be brought forward each month, the previous month's register pages being ruled off.

Station Control.—The forms presented will require careful use in order to supply an efficient and thorough check on stations and trucks. As mentioned, the total purchases reported by stations should agree with the same information from the voucher record. All interstation quantity transfers should balance out at the end of a month, after considering any items in transit. The sales of commodities which are passed through a meter pump are susceptible to very close check, except for unavoidable variations resulting from temperature changes; the quantities of all products sold will be automatically checked in the balancing of stocks.

In no circumstances should any station make expenditures from cash received at the station. An imprest change and petty cash fund should be maintained at each station, from which miscellaneous expense may be met. No station should be permitted to purchase products direct, except in the case of emergency.

CHAPTER XXIII

GENERAL ACCOUNTING RECORDS AND CLASSIFICATION OF ACCOUNTS

The common objection raised to an attempt at complete accounting in a marketing organization, is the considerable volume of detail involved. The system here presented is predicated on the assumption that the company desires to maintain a complete and accurate control of all transactions, and that the routine work will be carried out carefully and conscientiously.

The general accounting records will include the following:

General ledger
Journal voucher
Station and truck daily report,[1] Forms 30*a*, *b*, and *c* (pages 251, 252 and 253)
Summary of station and truck reports,[1] Form 31 (page 254)
Tank-car register,[1] Form 32 (page 255)
Voucher and freight record, Form 33 (page 256)
Cash voucher, Form 34 (page 257)
Cash receipts, Form 35 (page 258)
Cash disbursements, Form 36 (page 259).

Sales.—The record of sales will be obtained from two sources; the tank-car register will furnish a complete analysis of all jobbing and direct sales, while the summary of station and truck reports will record the sales made by stations and trucks. The total sales for the month can be brought into the general records by journal voucher. It is suggested that for convenience in summarizing, a separate binder be provided for the invoices of each class of sales in tank-car lots

Coupons.—Most companies sell coupon books, either allowing a cash discount of about 2½ per cent at the time of sale, or else redeeming the cover at a fixed price. As coupon books are sold, a liability account Unredeemed Coupons should be credited, and as collections of coupons are made, this account will be charged. The ledger balance at any time will represent the company's liability for outstanding coupons, and should be identifiable with specific coupon book numbers.

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[1] A full discussion of the methods to be employed in the use of these records is included in Chap. XXII.

Since a number of frauds have been perpetrated as a result of carelessly kept coupon records, care should be exercised to make the system adopted fool proof. A very good method is that of keeping a coupon book register containing, say, six columns for months. Each month's collection of coupons, after having been balanced, is sorted as to numbers, and the collections entered opposite each book registered. All coupons should be cremated after a reasonable time, in the presence of two or more persons, and a cremation certificate prepared. If properly kept, a coupon register will serve to prevent the Unredeemed Coupons account from becoming a heterogeneous mass of cross-entries.

Containers and Filling Cost.—A number of companies pack their products such as kerosene, oils and greases, in convenient-sized steel barrels, cans and similar containers. Some companies also maintain a cans and cases department, manufacturing their own smaller containers.

This department may be treated as a service department, separate costs being computed by the job method, and the production being charged into stores and supplies at cost; or, where small, the expenses of making containers and of filling may be treated as an expense, inventory being taken of containers on hand each month, both filled and unfilled.[1]

Returnable Containers.—When shipments are made in steel drums to customers, these returnable containers may best be kept track of by invoicing the customer with them at inventory value, and crediting his account upon their return. All drums should bear a serial number stenciled plainly upon them, and should also carry the name and address of the marketing company. Some companies find it a convenient practice to prepare an additional copy of the invoice or credit note in the case of all returnable containers. These copies can then be filed, and will form a perpetual inventory of the containers in hands of customers.

Between-station Transfer Freight.—Any freight expense resulting from transfers of product within the organization should be charged to an account captioned Between-station Transfer Freight. All freight charges should be approved by the traffic department before payment, since railroads have been known frequently to render duplicate bills.

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[1] Those readers who desire to inform themselves concerning can and case manufacture are referred to Bell, H. S., "American Petroleum Refining."

Sales and Export Taxes.—Any taxes and duties which the company is obliged to pay with respect to selling or exporting its commodities should be included as an expense.

In cases where purchases are made of products the purchase price for which includes a state gasoline tax already paid by the vendor, care must be taken that these taxes are not charged into product stocks; they should be charged to an account captioned State Tax Paid on Purchases, amongst the miscellaneous accounts receivable, and the total amount thereof deducted monthly from the liability accrued to the state. For a list of the gasoline taxes in effect in the various states, see Chap. XX.

Expenses.—In the classification of accounts here presented, expenses have been grouped by functioning departments. Where the company desires to keep account, for example, of steamer and barge expenses by voyages, a voyage register may be kept. This record will be operated upon the same principle as governs the keeping of a construction in progress record, an account being kept for each voyage.

In order that record may be had of the operating costs of individual stations and trucks, a subsidiary stations expense ledger may be opened, a sheet being allotted to each station. This form should be a columnar sheet, so that a separate column may be used for each subdivision of expense.

With respect to tank cars, some companies have found it worth while to maintain a subsidiary card record, showing the division of operating expenses in the case of each car. This is a matter for the company's discretion, but it may be mentioned that such analysis figures must of necessity be somewhat arbitrary.

Inventories.—In order to calculate cost of sales for any month, it is necessary that a summary be made of inventories, including those at distributing stations and service stations, and in motor trucks, tank cars, steamers, etc.

With regard to the pricing of inventories, the simplest method is that of using for each commodity the average price brought out by the tank-car register for the month, including original and between-station transfer freight.

The matter of the physical taking of inventories should be given careful attention. Product tanks, truck tanks, etc. should be strapped by someone versed in preparing tank tables, and these latter should be bound in a post binder, each table unmistakably identified with the tank for which it was made. The gravity and temperature of products gaged should be recorded by the gager, at the time the measurement is made, and tanks of products which are likely to contain water and sediment should be *thiefed* at the same time. It is permissible to gage tank outage, subtracting this gage from the long gage[1] of the tank to determine its contents, when the commodity is heavy fuel oil or road oil; however, in the case of light products and lubricants, the practice should not be countenanced.

In correcting volumetric measurements to 60°F., it is recommended that Bureau of Standards tables be employed, rather than some of the rough and ready methods in use (see table in Chap. XIX, page 204).

Authorizations for Expenditure.—All modern systems of accounting contemplate some method of controlling construction expenditures by means of properly approved authorizations, as well as the maintenance of a subsidiary capital asset record. The reader is referred to a discussion of these records in Chap. XV.

Accounting Records. *General Ledger.*—As in the other divisions of the industry, it is suggested that the journal style of loose-leaf ledger sheet be adopted for a marketing company, and that all ledger accounts be arranged in balance sheet and income account order.

Journal Voucher.—The journal voucher should be of such a size as can conveniently be filed in a post binder. Concerning the mechanics of handling journal vouchers the reader is referred to Chap. XIX.

Voucher and Freight Record (*Form* 33).—It is intended that this record be used for all cash vouchers, journal vouchers being posted direct to the general ledger. Provision has been made for the major classifications of assets and expenses, and the infrequently used accounts may be entered through the column headed Other Accounts.

Cash Voucher (*Form* 34).—The monthly cash vouchers should be assigned serial numbers, in the same manner as has been outlined for other divisions of the industry. The system of prefixing a letter or digit to denote the month, followed by the last two figures of the year, has been found very satisfactory; for example, either C-2527 or 3-2527 might be used for March, 1925, voucher No. 27.

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[1] "Long gage" is a term used to describe the full gage of a tank; an outage gage is a measurement of the unfilled space above the level of the product in the tank.

An excellent practice is that of stamping each supporting paper with the number of the voucher to which it belongs; this obviates the frequent difficulty of identifying detached papers.

Cash vouchers will be posted in the voucher record, and later against the checks issued therefor in the cash disbursements; in the case of product purchases in tank-car, freight-car or steamer lots, the vouchers will also be entered in the tank-car register, as will in-freight and between-station transfer vouchers.

Cash Receipts (*Form* 35).—The cash receipts record has been drawn up so that the daily station reports may be readily entered therein. The net cash banked by the station will be entered in the Amount Received and Bank Deposit columns, with the name of the bank indicated.

Where cash is received for the sale of coupon books, the gross value of the books will be extended into the Coupon Books Sold column, and the discount entered in the appropriate column. Strictly speaking, of course, this discount is applicable to the period over which the coupons are cashed, but is more conveniently taken up as an expense when the books are sold.

In the case of coupons redeemed, the amount shown on the daily report as coupons received, will be entered in the debit column, Coupons Redeemed; and similarly any cash shortages will be entered in the remaining debit column. It will therefore be seen that in balancing the cash book, the total of the amount received column, together with the totals of the two debit columns, will equal the total of the discounts allowed and the remaining distribution columns. This method of arrangement will save considerable time, and avoid the necessity for journalizing the amounts of coupons redeemed and cash shortages.

It will be noted that only one cash column is provided for bank deposits. However, a separate cash disbursements sheet will be used for each bank and the daily deposits carried over thereinto. At the end of the month, therefore, the total bank deposits can be posted to the general ledger from this latter record without the necessity of analyzing the deposit column in the cash receipts.

Cash Disbursements (*Form* 36).—This record is intended to serve as a register of checks. In no case should expenditures of cash be made from cash receipts; any petty cash expenses should be met from an imprest petty cash fund.

Payroll System.—The company's payroll record may well be drawn up in a style similar to Form 7 (page 90), the division of labor costs being accomplished by grouping the various employees' names by departments, stations, etc.

Where several workmen are engaged at a particular locality, the time-clock system may be employed. This will apply to such distributing stations as employ several helpers, to truck drivers, etc. In the case of service station attendants and other salaried employees, a salary section should be maintained in the payroll record. If the compensation of attendants is based wholly or partially on sales, provision may well be made in the payroll record for showing the amount upon which the commission is based, with reference to the station and truck daily report summary from which the information was obtained, and for the rate of commission.

A payroll deposit should be kept at the bank upon which the payroll checks are drawn, and the exact amount of each payroll, deposited at each pay period. As has been mentioned with respect to other divisions of the industry, the payroll should always be approved by responsible officials, and the distribution of pay checks undertaken at intervals by a representative of the accounting department; this distribution should be without any intimation concerning when it is to take place.

Depreciation.—The establishment of a card-record system for capital assets will be found to be of great assistance in computing depreciation; in connection with the method of maintaining such a record, see Chap. XV.

The following rates of depreciation, as recommended by the *Manual for the Oil and Gas Industry,* are based upon broad experience, and will be found to be generally applicable:

	Rate per Annum, Per Cent
Tankers	5
Barges, harbor tugs, or other small floating equipment	20
Tank cars	5
Filling stations:	
Ordinary wood or corrugated construction	20
Brick and concrete, or extraordinary construction	10
Distributing stations	10
Tank wagons:	
Motor type	25
Horse type	16⅔
Steel barrels	14²⁄₇
Tracks and switches	12½

(The rates recommended for various classes of tanks are shown in Chap. XIII.)

CARD OF ACCOUNTS FOR

CAPITAL ASSETS

Land
Buildings:
  Wharves and docks, and equipment
  Distributing stations
  Service stations
  Repair shop
  Office
Equipment:
  Tank steamers and barges
  Tank cars
  Distributing stations
  Trucks and wagons
  Service stations
  Repair shop equipment
Furniture and fixtures
Automobiles
Uncompleted construction
Reserve for depreciation (credit)

INVESTMENTS

Investments in and advances to affiliated companies
Other securities owned
Sinking fund deposits

CURRENT ASSETS

Material stores
Product stocks
Notes receivable
Accounts receivable—wholesale
Accounts receivable — service stations
Accounts receivable—miscellaneous
Reserve for doubtful accounts (credit)
Due from officers and employees
U. S. Government securities
Cash in banks
Petty cash funds

DEFERRED CHARGES

Insurance premiums unexpired
Interest prepaid
Unamortized expense on capital and bond issues
Prepaid expenses—miscellaneous

CAPITAL AND LIABILITIES

Capital stock—preferred
Capital stock—common
Funded debt
Purchase money obligations
Due to affiliated companies
Notes payable—bankers
Notes payable—others
Vouchers payable
Freight payable
Dividends payable
Unredeemed coupons
Salaries and wages accrued
Interest accrued
Taxes accrued
Other accrued expenses
Provision for Federal income tax
Reserve for contingencies
Capital surplus
Earned surplus
Dividends paid
Profit and loss

INCOME

Sales—gasoline
Sales—lubricating oils
Sales—greases
Sales—other
Sales allowances (debit)
Sales and export taxes (debit)
Cost of sales—gasoline
Cost of sales—lubricating oils
Cost of sales—greases
Cost of sales—other
Container and filling cost
Between-station transfer freight
Rental earnings
Discounts received
Investment income — affiliated companies
Investment income—other
Interest on Government securities
Miscellaneous income

CLEARING ACCOUNTS

Payroll
Depreciation
Taxes and insurance

A MARKETING COMPANY

EXPENSES

Tank steamers and barges:
- Labor
- Supplies and expense
- Repairs to wharves and docks
- Repairs to steamers and barges
- Depreciation of wharves and docks
- Depreciation of steamers and barges
- Insurance and taxes
- Product shortages

Tank cars:
- Rentals
- Tank-car mileage (credit)
- Supplies and expense
- Repairs
- Depreciation
- Insurance and taxes
- Product shortages

Distributing stations:
- Labor
- Supplies and expense
- Repairs
- Depreciation
- Insurance and taxes
- Product shortages

EXPENSES (*Cont.*)

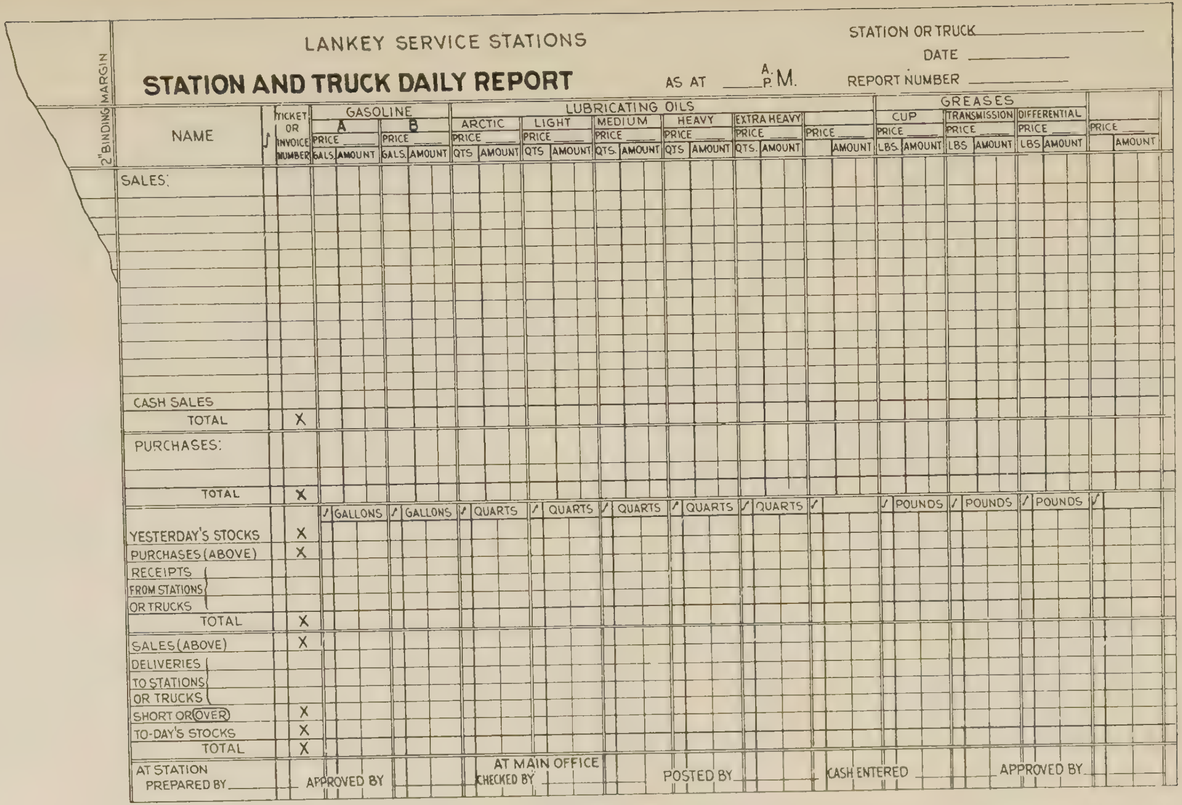
Trucks and wagons:
- Labor
- Supplies and expense
- Repairs
- Depreciation
- Insurance and taxes
- Product shortages

Service stations:
- Labor
- Supplies and expense
- Repairs
- Depreciation
- Insurance and taxes
- Product shortages

Administrative:
- Management salaries
- Office salaries
- Office supplies and expense
- Traveling auditors' expense
- Other traveling and automobile
- General taxes
- Legal and auditing
- General depreciation

General:
- Injuries and damages
- Charitable contributions
- Interest
- Discounts allowed
- Income tax
- Provision for contingencies

Suggested forms of records for a marketing company are shown on pages 251 to 259.



2" BINDING MARGIN

LANKEY SERVICE STATIONS

STATION AND TRUCK DAILY REPORT

AS AT ____ A.M. P.M.

STATION OR TRUCK ____

DATE ____

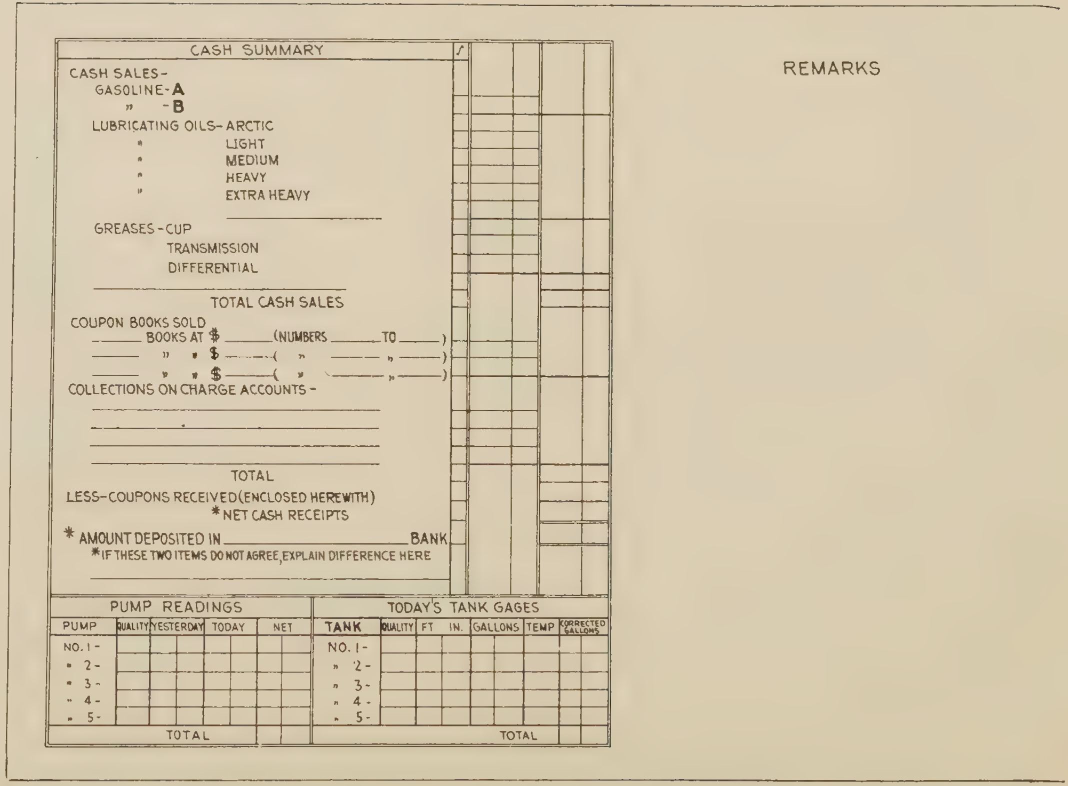
REPORT NUMBER ____

NAME	✓	TICKET OR INVOICE NUMBER	GASOLINE A PRICE ____ GALS.	GASOLINE A PRICE ____ AMOUNT	GASOLINE B PRICE ____ GALS.	GASOLINE B PRICE ____ AMOUNT	LUBRICATING OILS ARCTIC PRICE ____ QTS	LUBRICATING OILS ARCTIC PRICE ____ AMOUNT	LUBRICATING OILS LIGHT PRICE ____ QTS	LUBRICATING OILS LIGHT PRICE ____ AMOUNT	LUBRICATING OILS MEDIUM PRICE ____ QTS.	LUBRICATING OILS MEDIUM PRICE ____ AMOUNT	LUBRICATING OILS HEAVY PRICE ____ QTS	LUBRICATING OILS HEAVY PRICE ____ AMOUNT	LUBRICATING OILS EXTRA HEAVY PRICE ____ QTS.	LUBRICATING OILS EXTRA HEAVY PRICE ____ AMOUNT	PRICE ____	PRICE ____ AMOUNT	GREASES CUP PRICE ____ LBS.	GREASES CUP PRICE ____ AMOUNT	GREASES TRANSMISSION PRICE ____ LBS	GREASES TRANSMISSION PRICE ____ AMOUNT	GREASES DIFFERENTIAL PRICE ____ LBS	GREASES DIFFERENTIAL PRICE ____ AMOUNT	PRICE ____	PRICE ____ AMOUNT
SALES:																										
CASH SALES																										
TOTAL		X																								
PURCHASES:																										
TOTAL		X																								
			✓ GALLONS		✓ GALLONS		✓ QUARTS		✓ QUARTS		✓ QUARTS		✓ QUARTS		✓ QUARTS		✓		✓ POUNDS		✓ POUNDS		✓ POUNDS		✓	
YESTERDAY'S STOCKS		X																								
PURCHASES (ABOVE)		X																								
RECEIPTS FROM STATIONS OR TRUCKS																										
TOTAL		X																								
SALES (ABOVE)		X																								
DELIVERIES TO STATIONS OR TRUCKS																										
SHORT OR (OVER)		X																								
TO-DAY'S STOCKS		X																								
TOTAL		X																								

AT STATION PREPARED BY ____ APPROVED BY ____

AT MAIN OFFICE CHECKED BY ____ POSTED BY ____ CASH ENTERED ____ APPROVED BY ____

Form 30*a*.—Marketing department—station and truck daily report. (17 × 11 in. Loose leaf.)



CASH SUMMARY

CASH SALES-
GASOLINE-**A**
" -**B**
LUBRICATING OILS-ARCTIC
" LIGHT
" MEDIUM
" HEAVY
" EXTRA HEAVY

GREASES-CUP
TRANSMISSION
DIFFERENTIAL

TOTAL CASH SALES

COUPON BOOKS SOLD
_____ BOOKS AT $ _____ (NUMBERS _____ TO _____)
_____ " " $ _____ (" _____ " _____)
_____ " " $ _____ (" _____ " _____)
COLLECTIONS ON CHARGE ACCOUNTS-

TOTAL
LESS-COUPONS RECEIVED (ENCLOSED HEREWITH)
*NET CASH RECEIPTS
* AMOUNT DEPOSITED IN _____ BANK
*IF THESE TWO ITEMS DO NOT AGREE, EXPLAIN DIFFERENCE HERE

REMARKS

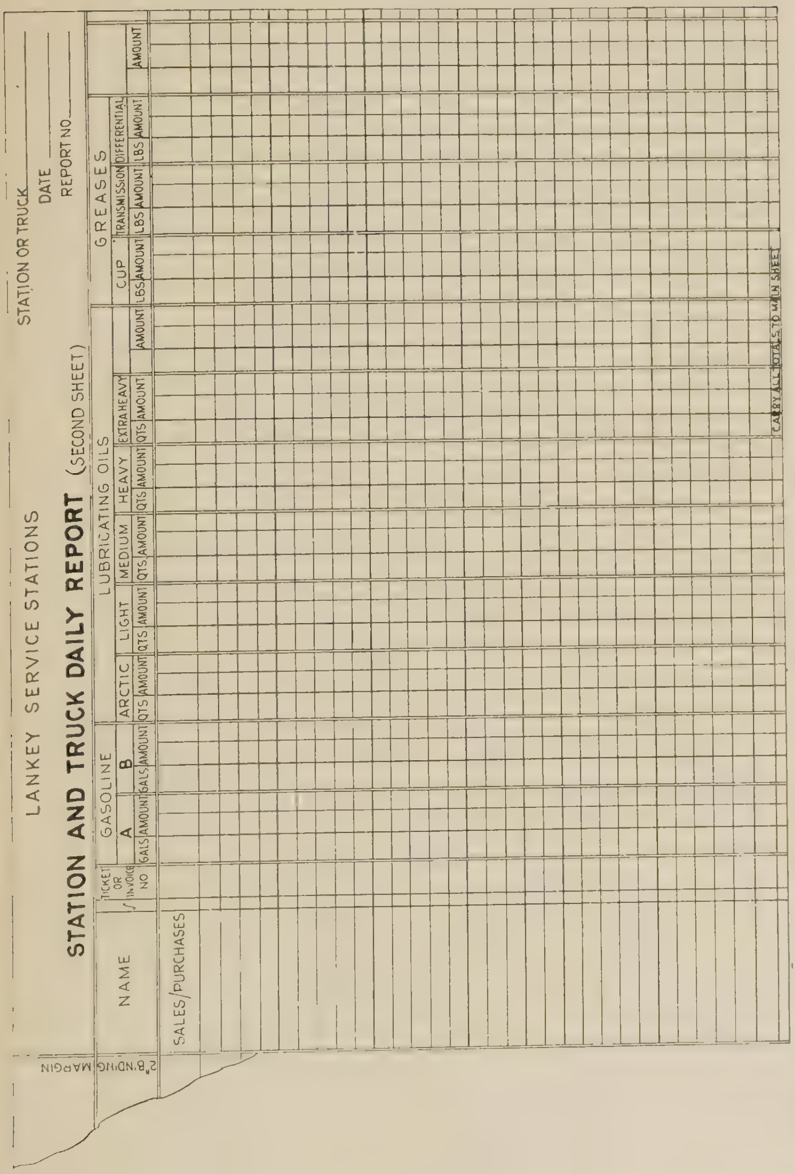
PUMP READINGS

PUMP	QUALITY	YESTERDAY	TODAY	NET
NO. 1-				
" 2-				
" 3-				
" 4-				
" 5-				
TOTAL				

TODAY'S TANK GAGES

TANK	QUALITY	FT	IN.	GALLONS	TEMP	CORRECTED GALLONS
NO. 1-						
" 2-						
" 3-						
" 4-						
" 5-						
TOTAL						

Form 30b.—Marketing department—station and truck daily report (reverse side). (17 × 11 in. Loose leaf.)



LANKEY SERVICE STATIONS

STATION AND TRUCK DAILY REPORT (SECOND SHEET)

STATION OR TRUCK ____
DATE ____
REPORT NO. ____

2" BINDING MARGIN	NAME		TICKET OR INVOICE NO.	GASOLINE				LUBRICATING OILS											GREASES					
				A		B		ARCTIC		LIGHT		MEDIUM		HEAVY		EXTRA HEAVY			CUP		TRANSMISSION		DIFFERENTIAL	
		✓		GALS.	AMOUNT	GALS.	AMOUNT	QTS.	AMOUNT	QTS.	AMOUNT	QTS.	AMOUNT	QTS.	AMOUNT	QTS.	AMOUNT	AMOUNT	LBS.	AMOUNT	LBS.	AMOUNT	LBS.	AMOUNT	AMOUNT
	SALES/PURCHASES																							

CARRY ALL TOTALS TO MAIN SHEET

FORM 30c.—Marketing department—station and truck daily report (second sheet). (17 × 11 in. Loose leaf.)

2" BINDING MARGIN

LANKEY SERVICE STATIONS

STATION OR TRUCK ______________

ITEM ______________

SUMMARY OF STATION AND TRUCK REPORTS MONTH OF ____________, 19 ___.

DAY	TOTAL AMOUNT (PURCHASES & SALES)	GASOLINE				LUBRICATING OILS												GREASES							
		A		B		ARCTIC		LIGHT		MEDIUM		HEAVY		EXTRA HEAVY				CUP		TRANSMISSION		DIFFERENTIAL			
		GALS.	AMOUNT	GALS.	AMOUNT	QTS	AMOUNT	QTS.	AMOUNT	QTS	AMOUNT	QTS	AMOUNT	QTS.	AMOUNT		AMOUNT	LBS	AMOUNT	LBS	AMOUNT	LBS.	AMOUNT		AMOUNT
1																									
2																									
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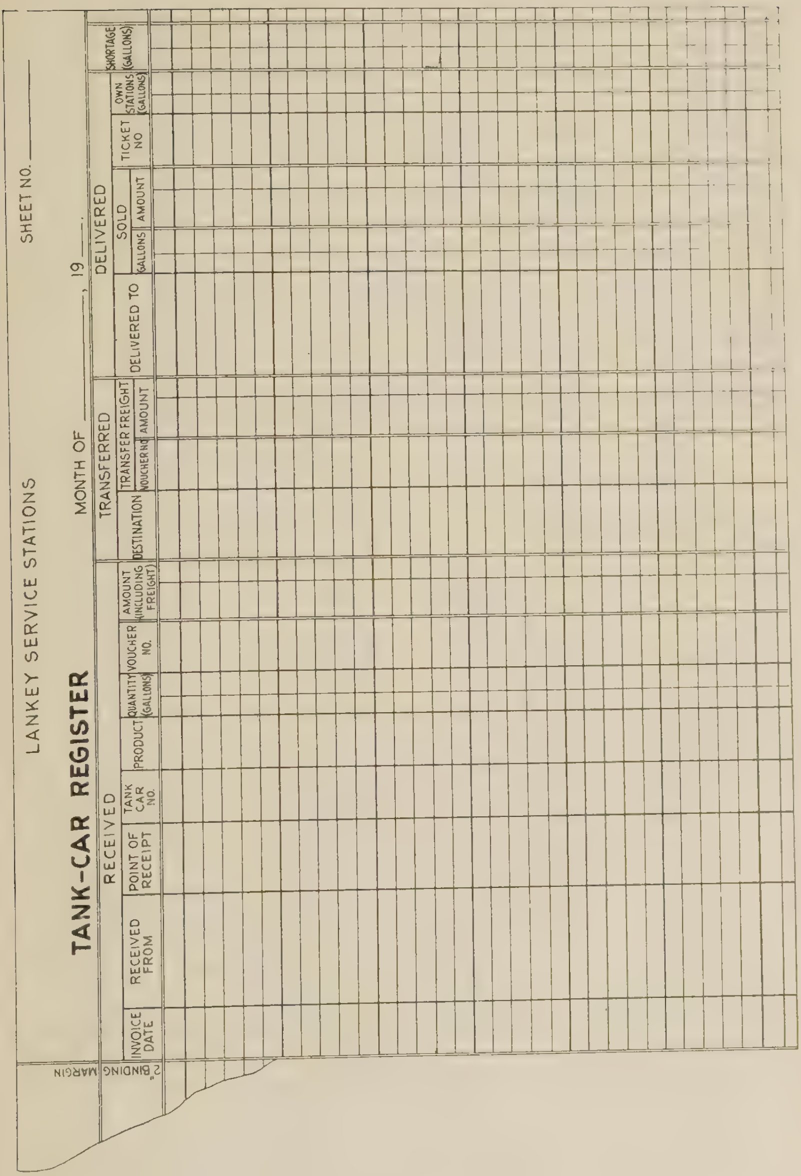
31																									

FORM 31.—Marketing department—summary of station and truck reports. (17 × 11 in. Loose leaf.)



LANKEY SERVICE STATIONS

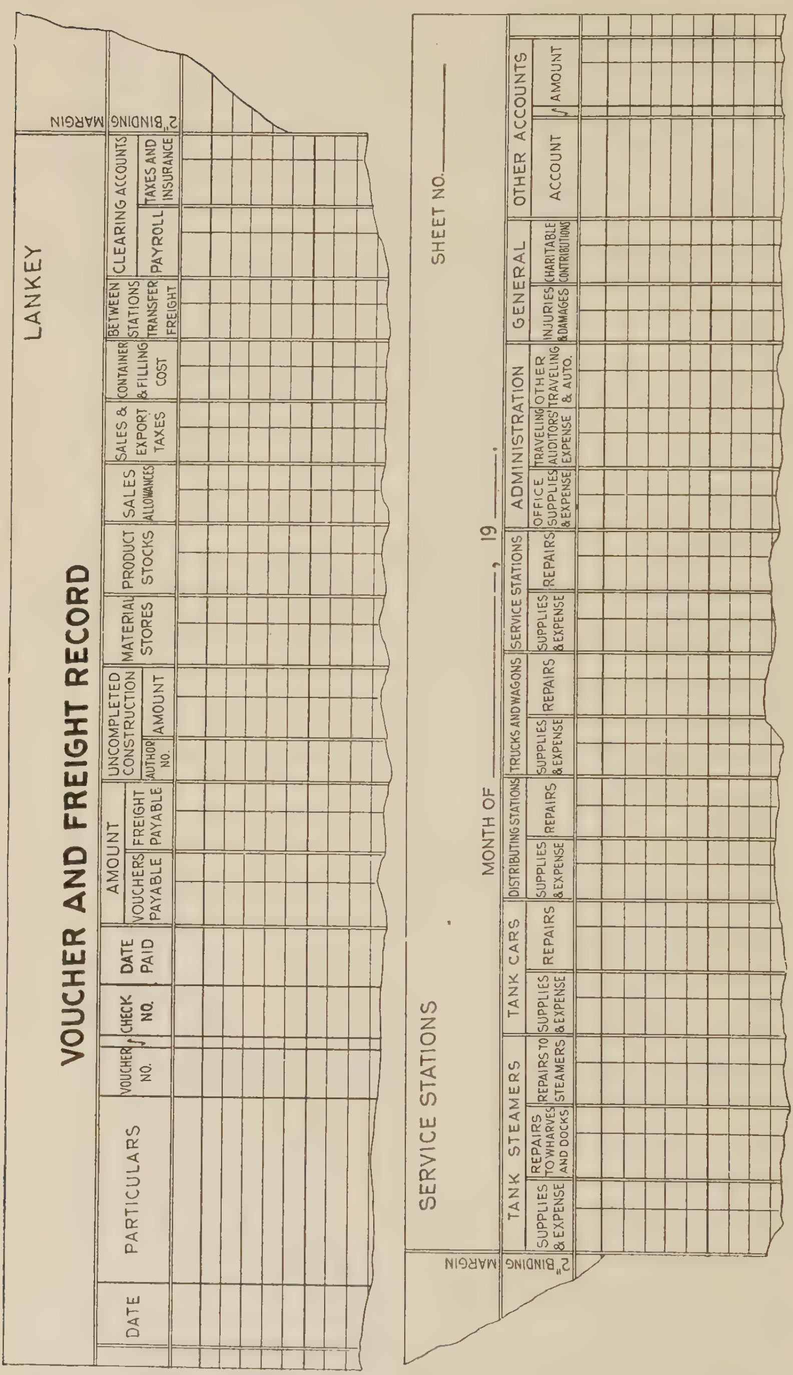
SHEET NO. ____

TANK-CAR REGISTER

MONTH OF ____, 19__

2" BINDING MARGIN	RECEIVED								TRANSFERRED			DELIVERED					SHORTAGE (GALLONS)
	INVOICE DATE	RECEIVED FROM	POINT OF RECEIPT	TANK CAR NO.	PRODUCT	QUANTITY (GALLONS)	VOUCHER NO.	AMOUNT (INCLUDING FREIGHT)	DESTINATION	TRANSFER FREIGHT		DELIVERED TO	SOLD		TICKET NO	OWN STATIONS (GALLONS)	
										VOUCHER NO	AMOUNT		GALLONS	AMOUNT			

FORM 32.—Marketing department—tankcar register. (17 × 11 in. Loose leaf.)



LANKEY

VOUCHER AND FREIGHT RECORD

DATE	PARTICULARS	VOUCHER NO.	✓	CHECK NO.	DATE PAID	AMOUNT		UNCOMPLETED CONSTRUCTION		MATERIAL STORES	PRODUCT STOCKS	SALES ALLOWANCES	SALES & EXPORT TAXES	CONTAINER & FILLING COST	BETWEEN STATIONS TRANSFER FREIGHT	CLEARING ACCOUNTS		2" BINDING MARGIN
						VOUCHERS PAYABLE	FREIGHT PAYABLE	AUTHOR. NO.	AMOUNT							PAYROLL	TAXES AND INSURANCE	

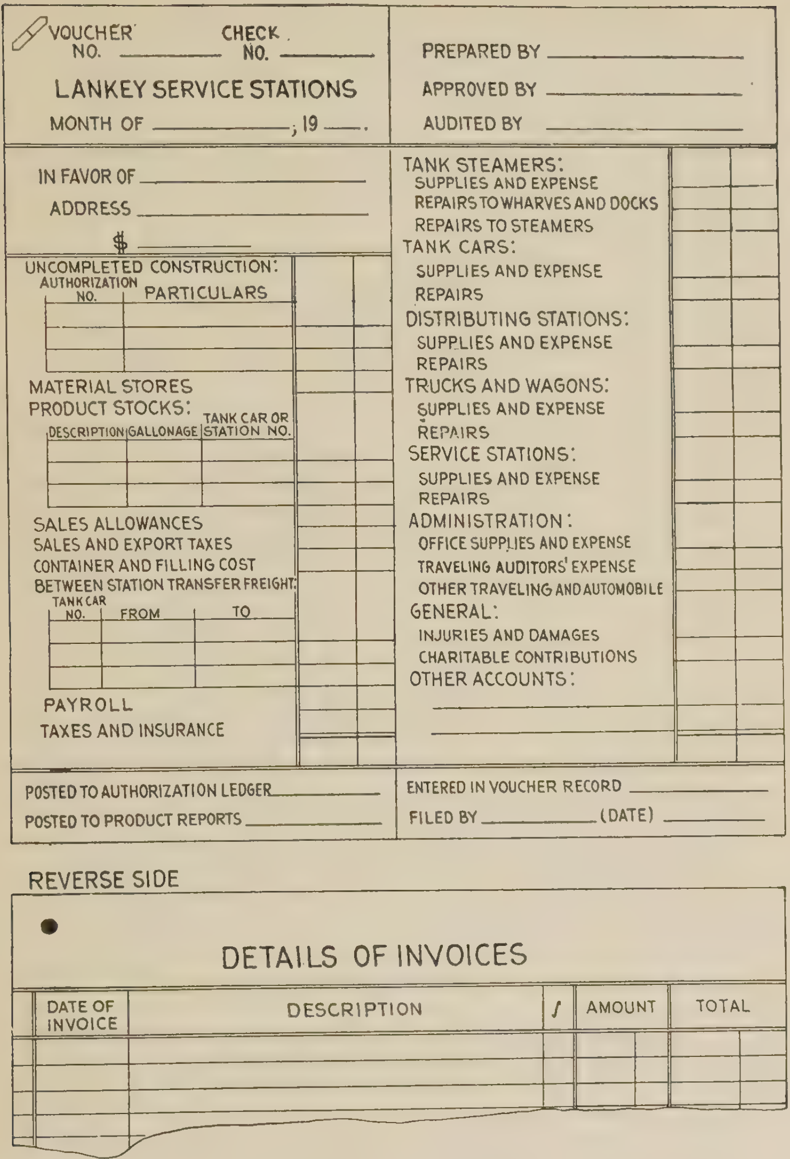
SERVICE STATIONS

MONTH OF ________, 19____.

SHEET NO.______

2" BINDING MARGIN	TANK STEAMERS			TANK CARS		DISTRIBUTING STATIONS		TRUCKS AND WAGONS		SERVICE STATIONS		ADMINISTRATION			GENERAL		OTHER ACCOUNTS		
	SUPPLIES & EXPENSE	REPAIRS TO WHARVES AND DOCKS	REPAIRS TO STEAMERS	SUPPLIES & EXPENSE	REPAIRS	SUPPLIES & EXPENSE	REPAIRS	SUPPLIES & EXPENSE	REPAIRS	SUPPLIES & EXPENSE	REPAIRS	OFFICE SUPPLIES & EXPENSE	TRAVELING AUDITORS' EXPENSE	OTHER TRAVELING & AUTO.	INJURIES & DAMAGES	CHARITABLE CONTRIBUTIONS	ACCOUNT	✓	AMOUNT

FORM 33.—Marketing department—voucher and freight record. (17 × 11 in. Loose leaf.)



VOUCHER NO. ______ CHECK NO. ______

LANKEY SERVICE STATIONS

MONTH OF ______, 19__.

PREPARED BY ______

APPROVED BY ______

AUDITED BY ______

IN FAVOR OF ______

ADDRESS ______

$ ______

UNCOMPLETED CONSTRUCTION:

AUTHORIZATION NO.	PARTICULARS

MATERIAL STORES

PRODUCT STOCKS:

DESCRIPTION	GALLONAGE	TANK CAR OR STATION NO.

SALES ALLOWANCES

SALES AND EXPORT TAXES

CONTAINER AND FILLING COST

BETWEEN STATION TRANSFER FREIGHT:

TANK CAR NO.	FROM	TO

PAYROLL

TAXES AND INSURANCE

TANK STEAMERS:
- SUPPLIES AND EXPENSE
- REPAIRS TO WHARVES AND DOCKS
- REPAIRS TO STEAMERS

TANK CARS:
- SUPPLIES AND EXPENSE
- REPAIRS

DISTRIBUTING STATIONS:
- SUPPLIES AND EXPENSE
- REPAIRS

TRUCKS AND WAGONS:
- SUPPLIES AND EXPENSE
- REPAIRS

SERVICE STATIONS:
- SUPPLIES AND EXPENSE
- REPAIRS

ADMINISTRATION:
- OFFICE SUPPLIES AND EXPENSE
- TRAVELING AUDITORS' EXPENSE
- OTHER TRAVELING AND AUTOMOBILE

GENERAL:
- INJURIES AND DAMAGES
- CHARITABLE CONTRIBUTIONS

OTHER ACCOUNTS:

POSTED TO AUTHORIZATION LEDGER ______

POSTED TO PRODUCT REPORTS ______

ENTERED IN VOUCHER RECORD ______

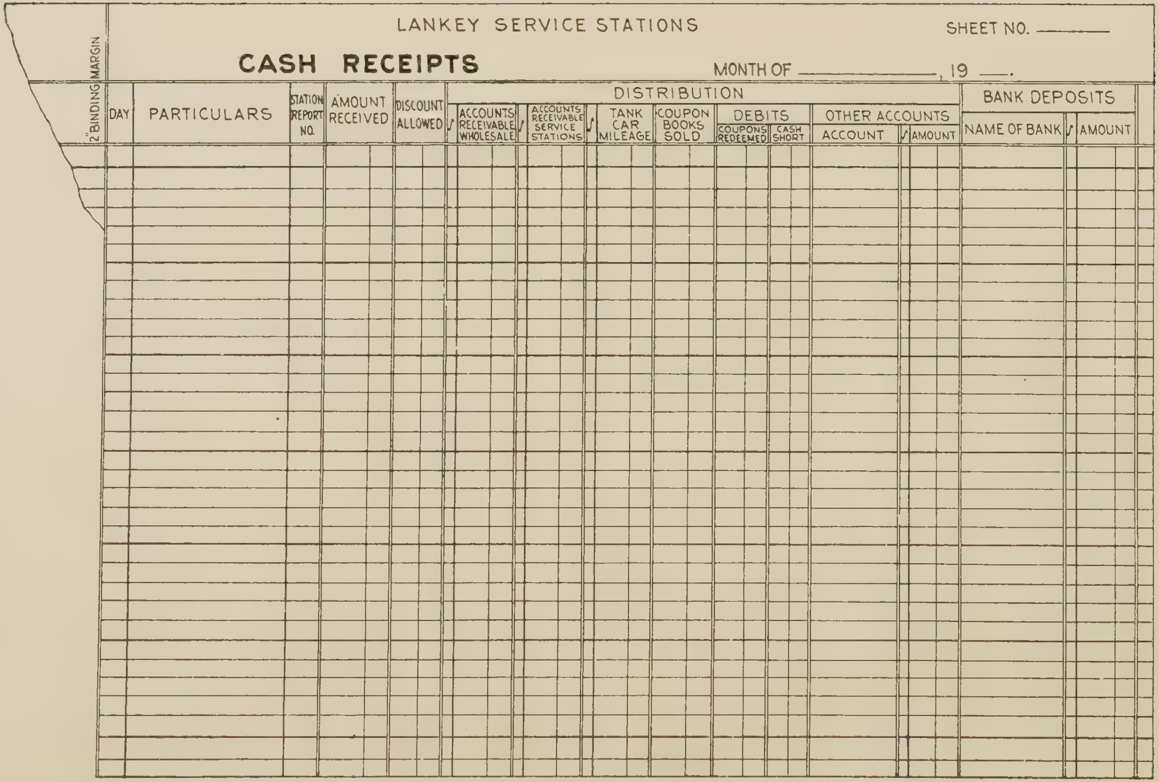
FILED BY ______ (DATE) ______

REVERSE SIDE

DETAILS OF INVOICES

DATE OF INVOICE	DESCRIPTION	/	AMOUNT	TOTAL

Form 34.—Marketing department—cash voucher. (8½ × 9¼ in.)



LANKEY SERVICE STATIONS

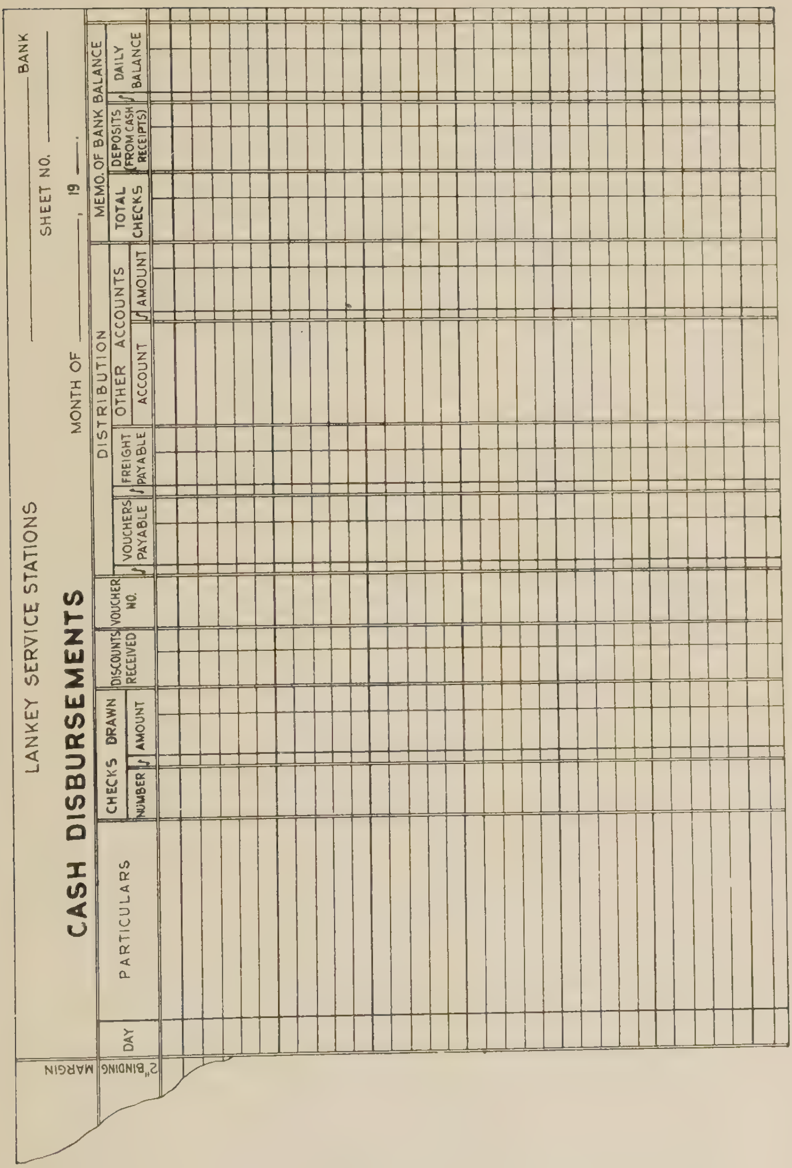
SHEET NO. ——

CASH RECEIPTS

MONTH OF ——, 19 —.

½" BINDING MARGIN	DAY	PARTICULARS	STATION REPORT NO.	AMOUNT RECEIVED	DISCOUNT ALLOWED	DISTRIBUTION													BANK DEPOSITS		
						√	ACCOUNTS RECEIVABLE WHOLESALE	√	ACCOUNTS RECEIVABLE SERVICE STATIONS	√	TANK CAR MILEAGE	COUPON BOOKS SOLD	DEBITS		OTHER ACCOUNTS				NAME OF BANK	√	AMOUNT
													COUPONS REDEEMED	CASH SHORT	ACCOUNT	√	AMOUNT				

Form 35.—Marketing department—cash receipts. (17 × 11 in. Loose leaf.)



LANKEY SERVICE STATIONS

SHEET NO. ________ BANK

CASH DISBURSEMENTS

MONTH OF ____________, 19___.

2" BINDING MARGIN

DAY	PARTICULARS	CHECKS DRAWN			DISCOUNTS RECEIVED	VOUCHER NO.	DISTRIBUTION							MEMO. OF BANK BALANCE			
											OTHER ACCOUNTS						
		NUMBER	✓	AMOUNT			✓	VOUCHERS PAYABLE	✓	FREIGHT PAYABLE	ACCOUNT	✓	AMOUNT	TOTAL CHECKS	DEPOSITS (FROM CASH RECEIPTS)	✓	DAILY BALANCE

Form 36.—Marketing department—cash disbursements. (17 × 11 in. Loose leaf.)

PART V

UNITED STATES FEDERAL TAXES

CHAPTER XXIV

THE OIL INDUSTRY AND FEDERAL TAXES

The subject of Federal income taxes as it affects the petroleum industry is worthy of an entire volume in itself. This is especially true by reason of the fact that we have had seven laws since 1909, and that each in succession has contained new provisions regarding the taxation of oil-producing companies.

From a practical viewpoint, only three revenue acts are of more than historic interest; the Revenue Act of 1924 at present in effect, represents a decided step forward, both from the standpoint of equitability and that of simplified procedure. The Revenue Act of 1921, predecessor of the present law, was a vast improvement over that of 1918, but left much to be desired.

It has been strongly urged that the subject of taxation be thoroughly covered in this volume; this would require more space than is available and would also demand very full abstracts of the laws and regulations, together with considerable comment. In the discussion of the various acts, it is intended to deal only with those features of the laws specifically relating to the petroleum industry, and with these along broad lines. Those readers who wish to study the entire subject of Federal income taxes, are referred to the Revenue Acts themselves, and to the regulations issued in explanation thereof, as well as to Robert H. Montgomery's invaluable annual *Income Tax Procedure.* At the time of writing, the Treasury Department's *Regulations* 62 are the most recent available, although *Regulations* 65 are in course of preparation.

Income Tax Provisions of Particular Interest in Earlier Laws.—The points of taxation procedure which are of especial interest to the petroleum industry arise almost entirely in connection with the production division; they may be stated as follows:

1. Depletion of oil and gas properties:
    - *a* Based on cost of properties.
    - *b* Based on fair market values as at Mar. 1, 1913.
    - *c* Based on discovery values.

2. Depreciation of wells and lease equipment:
    a Based on cost of equipment.
    b Based on fair market values as at Mar. 1, 1913.
3. Capital gains and losses arising from the disposition of capital assets.
4. Dividends paid from depletion reserves, or from realized appreciation.

Chapter IV of this volume has been devoted to the methods to be employed for computing depletion sustained and recording it on the books of account; it is suggested that Chap. IV be reviewed before proceeding with the present one.

Under the corporation Special Excise Tax Act of 1909, which was effective from the beginning of 1909 until Mar. 1, 1913, depletion was held not to constitute an allowable deduction from gross income, in determining the net income subject to tax. The act barely escaped being declared unconstitutional by the Supreme Court, by the fact that it was declared to be an excise tax, rather than an income tax. In addition to denying a deduction for depletion of oil properties as a charge against income for tax purposes, the law also contained other restrictive provisions.

The income tax law enacted Oct. 3, 1913, retroactively effective from Mar. 1, 1913, followed the passing of the Sixteenth Amendment to the Constitution, which made an income tax constitutional. Under this law, depletion was limited to "5 per centum of the gross value at the mine of the output for the year for which the computation is made." By reason of the low rates of taxation under both this and the 1909 law, taxpayers were not burdened with a heavy tax, during the time either remained in force.

The 1916 law, effective from Jan. 1, 1916, removed the depletion limitation of 5 per cent of the gross value of production, and provided:

> In the case of oil and gas wells a reasonable allowance for actual reduction in flow and production to be ascertained not by the flush flow, but by the settled production or regular flow . . . Provided, that when the allowances authorized . . . shall equal the capital originally invested, or in the case of purchase made prior to March first, nineteen hundred and thirteen, the fair market value as of that date, no further allowance shall be made.

The fact that subsequent acts and regulations have provided for a practical basis of computing depletion from the actual production during the period, and the estimated recoverable underground reserves, indicates that the so-called *reduction in flow* method was erroneous, both in premises and in principle. It assumed that oil reserves were reduced each year by the same percentage that the current year's production had declined, when compared with that of the preceding year. Though this may be roughly true in the case of natural gas, it is not now believed that the same principle can be applied in the case of oil.

The 1917 law, passed as an amendment to the already existing 1916 law, was made effective from Jan. 1, 1917, and was replaced by the Revenue Act of 1918 as of Jan. 1, 1918. It will be observed from the foregoing excerpt from the 1916 law, that depletion based on Mar. 1, 1913 values was an allowable deduction under both the 1916 and 1917 laws.

Revenue Act of 1918 (in force from Jan. 1, 1918 to Dec. 31, 1920).—The Revenue Act of 1918 was the first of the income tax laws to recognize the hazardous nature of exploitation for oil, and to make special concession to the oil industry in the discovery values provisions. The essential features of these sections of the law are that a taxpayer who discovers a well within the meaning of the law is entitled to base his depletion deduction for tax purposes upon a discovery value, rather than upon cost or upon Mar. 1, 1913 value; however, discovery valuations were held to have nothing whatever to do with invested capital, which was required to be based wholly upon cost.

The discovery section of the statute was not made retroactive, so that the fact that a taxpayer might have brought in a discovery well in (say) 1916 would not operate to allow him to base his 1916 and 1917 depletion deductions upon such discovery value, and to file amended returns for those years as a consequence. However, depletion for 1918 and subsequent years could be based on any discovery values arising subsequent to Mar. 1, 1913. In other words, if a well were drilled in on, say, Mar. 2, 1913, and it can later be proved that it was a discovery well within the meaning of the law, the taxpayer is entitled to base his depletion deductions for the year 1918 and subsequent years on such value, after allowing for depletion on the same basis during the years from 1913 to 1917, both inclusive.

Invested Capital.—Invested capital was an important factor in tax determination during the years 1917, 1918, 1919, 1920, and 1921. The underlying principle was that a business was entitled to a given percentage of return on its invested capital, before determining the amount of its net income subject to war profits and excess profits taxes. Beginning with the aggregate of the capital stock, surplus and undivided profits as shown by the books at the commencement of the year, various additions and deductions were made, in order to reach the invested capital as contemplated by the acts.

It should be remembered that values, either at Mar. 1, 1913 or at date of discovery, had nothing whatever to do with invested capital; invested capital represented the net assets at cost, after making provision for depletion and depreciation. Whether or not the taxpayer had been permitted to take as a deduction, under prior laws, the total depletion actually sustained, he was required to provide for the full amount thereof in his invested capital computations.

Revenue Act of 1921.—The Revenue Act of 1921 imposed the following rates of tax:

Individuals (citizens of the United States):

Normal tax at 4 per cent on the first $4,000 of the net taxable income, and 8 per cent upon the excess over $4,000.

Surtax on a graduated basis; for the year 1921, at 1 per cent on income between $5,000 and $6,000, and increasing regularly 1 per cent for each progression of $2,000 in net income up to $100,000 with further increases beyond that point up to 65 per cent on income in excess of $1,000,000; for the years 1922 and 1923 at somewhat lower rates up to 50 per cent on income in excess of $200,000.

Corporations (domestic):

Normal tax at 10 per cent of the net taxable income for the year 1921; and at 12½ per cent for 1922 and 1923.

Excess profits tax, for the year 1921 only, at the same rates as for the years 1919 and 1920 (see *Regulations* 62 or Montgomery's *Income Tax Procedure*).

Approximating Taxes.—In inserting the formulæ shown below in the present chapter, the authors have in mind the numerous cases, dating back several years, which have not yet been closed by the Department of Internal Revenue. Many companies, either in their own behalf or through accountant representatives, are obliged to prepare amended returns for some of the prior years for which formulæ are shown, in the course of disproving the justice of additional assessments resulting from field inspections.

In order that tax calculations may be simplified, and where a quick approximation of taxes is desired for some purpose, the formulæ will be found of use:

Where A = Invested Capital,
C = Net taxable income, and
X = Income, war profits and excess profits tax.

Year 1918:

When Section 302, limiting tax to 30 per cent of \$17,000, that is \$5,100, plus 80 per cent of net income in excess of \$20,000, is applicable,

$$X = .824C - \$9{,}832.$$

When the income falls in the 80 per cent bracket, without limitation,

$$X = .824C - .0704A - \$2{,}352.$$

When the income falls in the 65 per cent bracket, without limitation,

$$X = .692C - .08272A - \$1{,}032.$$

Years 1919 and 1920:

When the income falls in the 40 per cent bracket,

$$X = .46C - .0504A - \$740.$$

Supporting Claims for Abatement or Refund.—In preparing statements of various kinds for filing with the Department of Internal Revenue as support to claims for abatement, credit, or refund,[1] it will usually be found the better practice to make the statements as comprehensive as possible, omitting no essential information.

It has truthfully been said that income taxes are composed of about one point of law and nine points of accounting. It may be mentioned that taxation procedure, as it affects the oil industry, is much too technical to be left wholly in the hands of either an accountant, a petroleum engineer, or a lawyer. The proper functions of each of these specialists may be stated as follows:

The accountant should prepare the tax return, together with all supporting statements, basing depletion and depreciation calculations on the petroleum engineer's estimates of recoverable reserves. He should prepare all claims for abatement or refund, drafting the brief and the necessary statements in connection therewith, and should represent the taxpayer at all conferences.

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[1] It may be mentioned that the Board of Tax Appeals, constituted by the Revenue Act of 1924, has no jurisdiction in claims for refund of taxes overpaid during prior years.

Claims for abatement should be made in cases where the disputed amount of taxes has not been paid; claims for credit should be filed when an erroneous amount of tax has been paid, and the amount is being deducted from a tax payment for a later year; and claims for refund are applicable when an erroneous amount of tax has been paid, and the taxpayer is asking for a refund of the amount. Where a claim for refund has been filed, it is possible to substitute a claim for credit at a later date, using this claim as part of a subsequent tax payment. Of course, the taxpayer should only make such claims as he is convinced are just, according to the provisions of the tax laws; failure to observe this rule may involve a heavy fine.

The petroleum engineer should prepare all estimates of the company's oil and gas reserves, basing any discovery values upon the information thus obtained. He should also furnish a great many of the data required to support *Form* "O," including maps, undrilled locations, etc.

The lawyer should represent the company in case of litigation, and advise on technical legal interpretations. Where conferences are important the company's attorney should be present.

Firms of public accountants are frequently called upon to undertake the unraveling of tax cases which have been left wholly in the hands of the company's attorney; and, as a matter of fact, many attorneys engage public accountants to prepare all statements and supporting schedules in a tax case, merely adding the accountants' fee to their own bill to the client.[1] It is highly desirable that each profession recognize its limitations.

The first step where an additional assessment has resulted from a field audit, is to compare in statement form the various amounts shown by the company's return with those arrived at by the inspector; this form of statement is especially desirable when a professional accountant is undertaking the work of rebutting the assessment, since it furnishes him with a comprehensive view of the entire situation. The following percentages, for the years 1919 and 1920 as an example, may be used in calculating the portion of the additional tax which is attributable to each change in invested capital or income, made by the inspector. These percentages are only applicable when the income falls in both brackets:

Invested capital	5.04 per cent of change made
Taxable income	46.00 per cent of change made.

The following hypothetical case assumes an invested capital of $300,000 as computed by the company, and a reduction to $275,000 by the inspector; since the amount of tax involved by this change is relatively small, it is immediately apparent that the point is not an important one. Depreciation expense has been decreased by $15,000, involving $6,900 of the additional assessment, while selling expense has been lowered by $5,000, accounting for another $2,300 of the additional tax. It is apparent that the points in the case are to substantiate the depreciation and selling expense deductions as orginally claimed, leaving the other items to which exception was taken, for minor consideration:

---

[1] An example of this practice is furnished in the case of one of the wealthiest tribes of Indians in the world. The matter of preparing the tax returns for the tribe is somewhat complex, since depletion is a very important factor. For several years, the preparation of these returns has been in the hands of a certified public accountant of recognized ability; the accountant, however, undertakes the work for a firm of attorneys who have had the contract since about 1920.

Particulars	Per original return	Per inspector's report	Changes Increase (*) or decrease	Tax involved (increase)
Invested Capital	$300,000	$275,000	$25,000	$ 1,260
Net Income:				
Net sales	$200,000	$200,000		
Cost of goods sold	50,000	50,000		
Gross profit	$150,000	$150,000		
Expenses:				
Depreciation	$ 25,000	$ 10,000	$15,000	6,900
Selling	15,000	10,000	5,000	2,300
Administrative	5,000	3,000	2,000	920
Total expenses	$ 45,000	$ 23,000	$22,000	
Net income	$105,000	$127,000	$22,000*	
Total tax	$ 32,440	$ 43,820	$11,380*	$11,380

Depletion Based on Cost (see also Chap. IV).—Where a deduction from income for depletion of oil or gas properties is claimed in a tax return, Form "O,"[1] as promulgated by the Natural Resources Division, should be made out by the taxpayer for each lease upon which depletion is claimed. The form is both exhaustive and self-explanatory, and it would appear unnecessary to dwell upon it here; copies may usually be had from the local tax collector's office.

Depletion, in most cases, is best calculated on each lease; an attempt to compute depletion on each well will not ordinarily be satisfactory, as data concerning the production of individual wells are seldom available. From an accounting viewpoint, moreover, depleting wells individually is fundamentally unsound, since the operator is concerned with extracting the total recoverable oil and gas reserves of the lease, rather than the supposed reserves which single wells may produce; the wells are but means to an end, not separate economic entities. An oil well is not simply a convenient connection between an underground reservoir and the surface of the earth; it is a penetration of an oil-saturated sand, shale, or limestone, and it may drain not only the oil underlying, say, 10 acres of the company's property, but also oil reserves from adjacent properties.

---

[1] When once Form "O" has been filed for an oil or gas property, it is not necessary to file it again for the particular property during ensuing years.

Many companies, during the high tax years, took advantage of the provision in the laws permitting the taxpayer the election of charging off intangible development costs currently as expense, rather than capitalizing the amounts and recovering them through depletion charges. In these cases the depletable capital sum is the bonus paid for the lease, or cost in fee, plus any capitalized incidental expense. Where development costs are added to capital, however, the annual expenditure in this respect should be charged to the cost of the lease, and depletion taken for the year on the entire amount.

Statements of depletion sustained in connection with operating oil properties are best set up in a style similar to that shown by Form 10*a*, page 93 of this volume. In the case of depreciation statements, the headings may be worded along the same lines. Where the schedule concerns depletion of discovery values, the wording should so indicate, and a memorandum may well be entered of the amount of depletion claimed in the company's tax returns, where this differs from the amount shown by the records.

Depletion Based on Mar. 1, 1913 Value.—The underlying theory of permitting taxpayers to base depletion charges upon Mar. 1, 1913 values in the case of properties acquired prior to that date, is that such values constituted the taxpayer's capital, as far as the income tax laws are concerned, at the date the Sixteenth Amendment to the Constitution became effective. Although the intent of previous laws has been somewhat obscure concerning whether it was mandatory upon the taxpayer to base depletion computations on a Mar. 1, 1913 value, when this value was less than cost after allowing for production to that date, the Revenue Act of 1924 is clear in this respect, permitting the taxpayer to base his calculations upon cost or Mar. 1, 1913 value, *whichever is greater*.[1]

---

[1] Revenue Act of 1924, Sec. 204, subdivisions (*b*) and (*c*).

There is no limitation upon the *annual* amounts of depletion, based on Mar. 1, 1913 value, which may be taken as a deduction; this is true of all laws since that of 1916. However, as soon as the depletion reserve equals the value established and approved by the Department, no further deduction may be taken, no matter how much more production may be obtained. This latter is equally applicable in the case of depletion based on cost or on discovery value.

There are two methods in general use for establishing and substantiating Mar. 1, 1913 values. Under one method, proof in the shape of documentary evidence is submitted to the Department, tending to show that the value claimed is reasonable, "assuming a transfer between a willing seller and a willing buyer as of that particular date." The evidence may also take cognizance of other relevant facts, such as the price per barrel for which production was selling in the vicinity at the basic date,[1] prices at which similar properties changed hands, valuation for local or state taxation, disinterested appraisals, etc.

The second means of determining the value is by what is termed the *present value* method. The factors under this method, as set out in *Regulations* 62, are:

1. Recoverable oil and gas reserves at Mar. 1, 1913.
2. Quality or grade of the oil and gas.
3. Expected percentage of marketable commodity which will be recovered from the production.
4. Expected operating life in years.
5. Estimated lifting cost per unit, excluding depletion and depreciation.
6. An interest rate commensurate with the risk.

Since the company will have the production records of the lease available, no difficulty should be encountered in determining the approximate reserves at Mar. 1, 1913, employing the methods outlined in Chap. IV. The quality of the oil and gas will be quite readily determinable from that of the current production; this production will also establish the percentage of the total production which will ultimately be a marketable commodity, after water and sediment have been removed.

---

[1] Many operators buy or sell properties at a price per barrel of daily production. For example, Pennsylvania and West Virginia production often sells at from $2,000 to $5,000 per barrel per day, while from $500 to $1,000 is generally obtained in the Mid-continent field.

The expected operating life in years will be determined when the estimates of recoverable reserves are prepared. The estimated operating cost per barrel, or thousand cubic feet as the case may be, will best be secured from the actual operating records; from such cost should be excluded depletion, depreciation and any development costs which the company may have written off to expense.[1]

The *interest rate commensurate with the risk* is somewhat vague, and a fair determination thereof is difficult; the rate would probably be so high as to be prohibitive; 8 per cent per annum is quite generally used.

Having determined each of the foregoing factors, the problem is simply one of calculating the expected net income from the lease each year from Mar. 1, 1913 until the year of its probable exhaustion and abandonment,[2] and of reducing each year's net income to its present value at Mar. 1, 1913. This is best done by the following formula:

$$\text{Present value of any year's net income} = \frac{\text{Net income for the year}}{(1.08)^n},$$

where 8 per cent is the assumed interest rate, and n represents the number of periods which the particular year is from Mar. 1, 1913. It may be mentioned that, equitably, each year's income should be discounted for only a portion of that year, rather than for the full year, since the production will have accrued ratably throughout the entire year.

The statements to be submitted to the Department, with respect to depletion based on Mar. 1, 1913 values, should be in much the same form as was indicated for depletion based on cost. Of course, such evidence as is pertinent should be submitted to support the values claimed.

Depletion Based on Discovery Value.—There is a saying among the older operators that "an oil well is a hole in the ground, and the owner is a liar!" No doubt the Department of Internal Revenue is inclined to subscribe to the opinion that at any rate owners are often much too optimistic, especially in view of some of the astonishing claims to discovery which are submitted for its consideration.

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[1] *Regulations* 62, Art. 206 (A), subdivision *d*.

[2] Actual figures have been accepted for this purpose, where they are available.

Depletion based upon discovery values, for income tax purposes, was first allowed under the 1918 law. It was reënacted in the Revenue Act of 1921, with the qualifying provision that the depletion so computed might not exceed the net income from the lease to which it belonged, nor be included in any net loss carried forward to succeeding years. The effect of the first provision was to prevent the taxpayer from offsetting the loss on one lease, arising from depletion based on a discovery value, against an operating gain from some other source; the second provision simply limits the benefit from the concession, to the year in which the depletion is sustained.

The Revenue Act of 1924 further limits the amount of depletion based upon discovery value, to 50 per cent of the net income from the particular lease.

The discovery of an oil or gas well must satisfy the following two conditions of the regulations:

(*a*) The fair market value of the oil or gas well on the date of discovery or within thirty days thereafter must have become materially disproportionate to the cost, as a result of the discovery, and

(*b*) Such oil or gas well must not have been acquired as the result of purchase of a proven tract or lease.

Discovery of an oil or gas well results from the taxpayer's having located either a natural outcropping or, through the drilling of a well, oil or gas (or both) in quantities sufficient to assure him a reasonable profit, or at least the return of the capital which he was obliged to invest in developing the property; provided, however, that the well must not have been drilled within what is technically termed a proven area.

A proven area is defined by the regulations as "that portion of the productive sand or zone or reservoir included in a square surface area of 160 acres having as its center the mouth of a well producing oil and/or gas in commercial quantites." From this it will be observed that:

1. The first well drilled in an unproved territory proves the 160 acres of which it is the center; this without regard to private boundaries.

2. The proving is with respect to a sand or zone or reservoir; in other words, the fact that one sand has previously been discovered does not operate to preclude discovery of, say, a deeper sand hitherto undrilled.

3. Although the taxpayer's property may never have been drilled by himself, still it may lie within an area proved by the well of some other taxpayer, thus preventing a discovery well; however, if the property was acquired by the taxpayer before the other operator's discovery well was drilled, the taxpayer is not estopped from claiming a discovery.[1]

The property which may be valued after discovery is the well, the term well embracing the drill hole, the surface area necessary for drilling and operating the well, and the oil and gas content of the sand from which the discovery well draws its production; however, the value must contemplate only such reserves in the particular sand as lie within the taxpayer's property boundaries, and must not consider any reserves beyond the limits of the area which the well proves. A well will usually drain about five acres, although in many fields a well is supposed to drain 10 acres.

In Fig. 8 the principle of discovery is illustrated; the following explanation will serve to make the illustration somewhat clearer. It is assumed that the properties were acquired on the dates indicated, and that wells were completed as follows:

	DATE ACQUIRED	WELL NO.	COMPLETED
A	Jan. 1, 1924	A-1	Sept. 15, 1924
B	July 1, 1924	B-1	Sept. 1, 1924
		B-2	Sept. 5, 1924
C	Oct. 1, 1924	C-1	Oct. 30, 1924
D	Oct. 1, 1924	D-1	Oct. 30, 1924
		D-2	Nov. 1, 1924

Taking the wells in the order in which they were completed, and assuming that all are in the same sand, we find that B-1, drilled-in Sept. 1, 1924, is a discovery well, as also is B-2, completed Sept. 5, 1924. A-1, although drilled within the area proved by B-1, is also a discovery, since A acquired his property before B-1 was drilled. C-1, completed on Oct. 30, 1924, is a discovery, although had it been drilled at the point marked (X) it would not have been. D-1, completed on Oct. 30, 1924 within the area proved by B-2, is not a discovery as D acquired his property after B drilled the well; D-2, completed on Nov. 1,

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[1] See *Regulations* 62, Art. 220 (a), par. 2, which reads "So much of a taxpayer's tract or lease which lies within an area proven either by himself or by another is 'a proven tract or lease' as contemplated by the statute, and the discovery of a well thereon will not entitle such taxpayer to revalue such well for the purpose of depletion allowances, unless the tract or lease had been acquired before it became proven."

1924 within the area proved by D-1, is not a discovery either; had D drilled D-2 before D-1, however, he would have been entitled to claim a discovery.

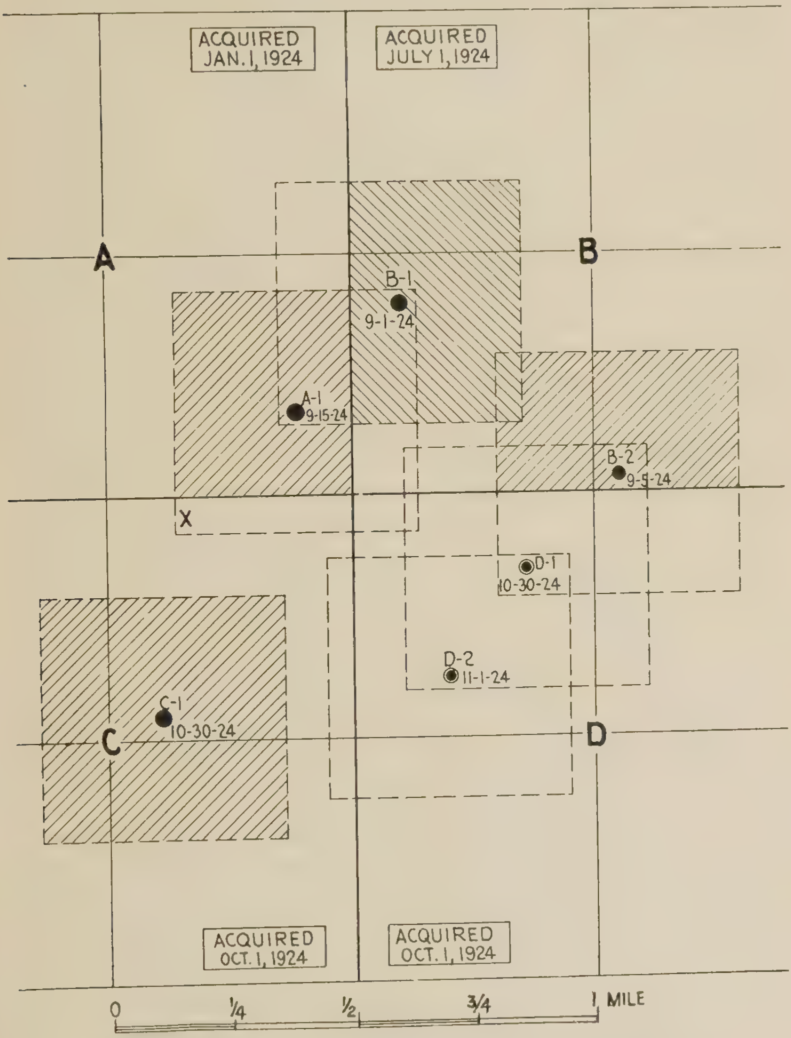

FIG. 8.—Illustrations of discoveries under Federal Tax Laws.

It should be clearly understood that all *producing wells* prove the 160-acre tracts surrounding them, and not merely *discovery wells.* The *Regulations* (Art. 220(*a*), subdivision (2)) are quite clear on this point, though the terms used may mislead the taxpayer if considered apart from the definitions set out in the regulations. A well drilled in an already proved area will therefore extend the proved area, although it will not be a discovery well, except in the special case previously cited.

In submitting a claim for discovery, the company should always endeavor to furnish the Department of Internal Revenue with complete information concerning the development of adjacent properties including the maps mentioned in Form "O." A very convenient method of preparing maps for a property as of different dates, to show the progression of development work, is that in which a master map is used as a basis, and a transparent tracing-cloth map is made of the subsequent development. The maps should be bound in such a manner that the transparency will fall exactly over the heavier drawing, thus showing the status of the property as of the later date. This method is employed by a leading firm of petroleum engineers, and has proved to be very satisfactory.

Needless to say, no pains should be spared to make the information furnished in Form "O" both complete and accurate. It is confidently believed that if the company maintains its records along the lines indicated in the first part of this volume, very little difficulty will be experienced in substantiating any meritorious claim. It may be added that probably one-fourth of the additional assessments made as a result of field inspections, are based on recommendations which the agent was obliged to make solely in self-defense. In short, if records are incoherent and poorly kept, the agent is very likely to recommend the assessment of additional taxes simply (and rightly) to compel the taxpayer to put his house in order.

Depreciation of Wells and Lease Equipment.—The problems which are met with in calculating depreciation have already been discussed in Chap. VI, and it is suggested that that chapter be referred to in considering depreciation under the tax laws.

Since 1916, taxpayers have been permitted to base their depreciation charges on Mar. 1, 1913 values, when such values were greater than cost; prior to the Revenue Act of 1924, the regulations have always read somewhat as follows:

> The capital sum to be replaced by depreciation allowances is the cost of the property . . . except that in the case of property acquired by the taxpayer prior to March 1, 1913, the capital sum to be replaced is the fair market value of the property as of that date.

This section has been construed as requiring the taxpayer to base depreciation charges on Mar. 1, 1913 values, even when such values were less than depreciated cost at that date. However, the Revenue Act of 1924 very plainly states:

> cost . . . or fair market value of such property as of March 1, 1913, whichever is greater.

When depreciation computations are based on Mar. 1, 1913 values, which latter will in all probability simply represent depreciated cost, it should be remembered that the rates prescribed for various classes of physical equipment by the *Manual for the Oil and Gas Industry* contemplate original costs, not depreciated costs.

In setting up in statement form depreciation sustained on wells and lease equipment, it is suggested that the statement be drawn up along the lines of Form 10*a*, page 93; assuming, of course, that depreciation is being calculated on the units produced basis.

Capital Gains and Losses Arising from the Disposition of Capital Assets.—Realizing that the high surtaxes and excess profits taxes were practically confiscatory in the case of sales of oil and gas properties which taxpayers had located and developed, Congress in the various tax laws provided as follows:

Years 1918, 1919, 1920:

Regulations 45, *Art.* 13. *Surtax on Sale of Mineral Deposits.*—Where the taxpayer by prospecting and locating claims, or by exploring and discovering undeveloped claims, has demonstrated the principal value of . . . oil or gas wells, which prior to his efforts had a relatively minor value, the portion of the surtax attributable to the sale of such property or the taxpayer's interest therein shall not exceed 20 per cent of the selling price.

Regulations 45, *Art.* 971. *War Profits and Excess Profits Tax on Sale of Mineral Deposits.*—In the case of a sale of . . . oil or gas wells, or any interest therein, as described in Art. 13, the portion of the war profits and excess profits tax attributable to such a sale shall not exceed 20 per cent of the selling price.

Years 1921, 1922, 1923:

Regulations 62, *Art.* 13. *Surtax on Sale of Mineral Deposits.*—The provision is the same as for the years 1918, 1919, and 1920, except . . . "shall not exceed for the calendar year 1921, 20 per cent, and for subsequent calendar years 16 per cent of the selling price."

Regulations 62, *Art.* 971. *War Profits and Excess Profits Tax on Sale of Mineral Deposits.*—The article remains unchanged for the year

1921, after which date the war profits and excess profits taxes were no longer applicable.

Year 1924:

> *Revenue Act of* 1924. *Sec.* 211 (*b*).—In the case of a bona fide sale of . . . oil or gas wells, or any interest therein, where the principal value of the property has been demonstrated by prospecting or exploration and discovery work done by the taxpayer, the portion of the tax imposed by this section (that is, surtax) attributable to such sale shall not exceed 16 per centum of the selling price of such property or interest.

The Revenue Act of 1921 provided that in the case of an individual, the gain arising from the disposition of capital assets (and it should be noted that this would include oil and gas properties sold) might be taxed separately at a flat rate of 12½ per cent, this tax supplanting any normal and surtax which otherwise might be payable thereon. However, the law further provided that the sum of the tax so computed and the normal and surtax on ordinary income, might not be less than 12½ per cent of the total net income from both sources.

The Revenue Act of 1924 reënacts essentially the same provisions with regard to capital gains and losses.

Dividends Paid from Depletion Reserve.—There seems to exist some doubt as to the proper method for recording a dividend paid from a depletion reserve, or from realized appreciation. As far as the recipient of such a dividend is concerned, a payment from a depletion reserve calculated on cost is a return of capital, and is not taxable. The same is true in a degree of a dividend paid from realized appreciation for, although such a payment differs in no material respect from ordinary dividends, yet dividends from earnings accrued prior to Mar. 1, 1913 are not taxable to the stockholder. It is to be noted, however, that a dividend received from the realized portion of appreciation arising from discovery values *is* taxable to the recipient.

The payment of a dividend from a depletion reserve is, then, in effect a liquidating dividend. For example, assume the following balance sheet:

Assets (all)	$50,000
Less: Depletion reserve	10,000
	$40,000
Capital stock	$40,000
Surplus	......
	$40,000

Assume that the company decides to pay a dividend of $5,000, and states that this sum is being paid from the depletion reserve. The real error of the matter lies in the management's erroneous conception of the nature and purpose of a depletion reserve. Tersely stated, it measures a hole in an asset, thus showing the amount by which a portion of the capital assets has been converted through exploitation into other assets. It is manifest that to reduce this reserve by charging against it a dividend payment of $5,000, is exactly equivalent to charging the dividend into the asset account, and is entirely incorrect. The payment should be charged to a ledger account captioned "liquidating dividend," and the balance sheet will then be as follows:

Assets (all)	$45,000
Less: Depletion reserve	10,000
	$35,000
Capital stock	$40,000
Less: Liquidating dividend	5,000
	$35,000
Surplus	......
	$35,000

A dividend paid from realized appreciation, on the other hand, constitutes a return of capital only to the extent that such appreciation arose from Mar. 1, 1913 values, and then only from the viewpoint of the recipient under the income tax laws. This statement assumes that the individual has owned the stock since the inception of the company, or thereabouts, and did not acquire it by outside purchase at a price in excess of par value; in other words, a dividend paid from earnings accrued at the date the stockholder acquired the stock would be return of capital from an accounting point of view.

As far as the paying company is concerned, a dividend from realized appreciation differs in no way from an ordinary dividend as regards its treatment in the books of account.

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